016.53
P578
Illinois U Library

PHYSICS ABSTRACTS

SECTION A

of

SCIENCE ABSTRACTS

SECTION A, PHYSICS

SECTION B, ELECTRICAL ENGINEERING

Edited and Issued Monthly by

THE INSTITUTION OF ELECTRICAL ENGINEERS

In Association with

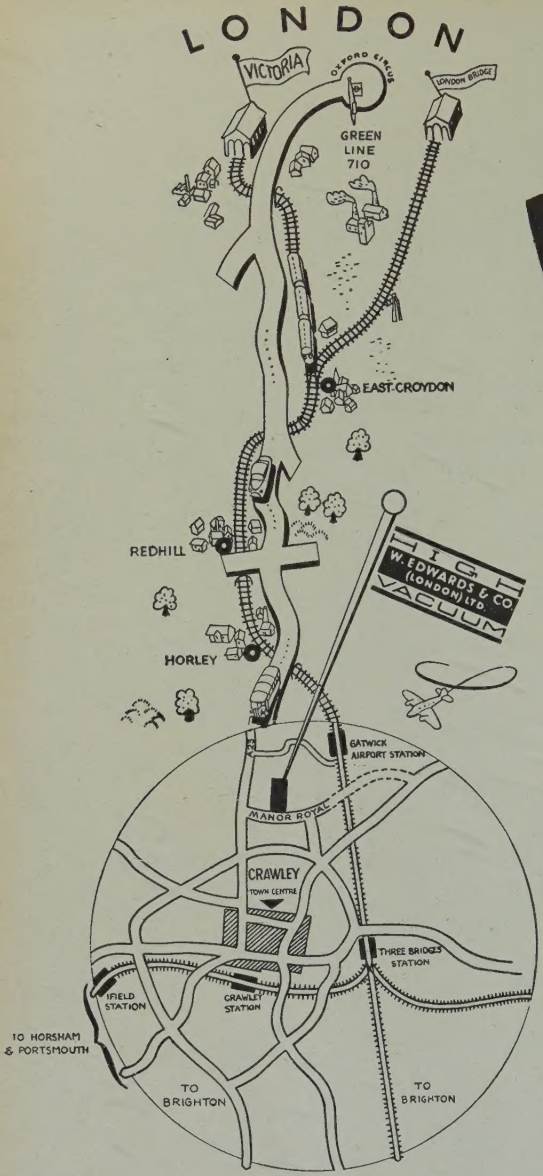
THE PHYSICAL SOCIETY

THE AMERICAN PHYSICAL SOCIETY

THE AMERICAN
INSTITUTE OF ELECTRICAL ENGINEERS

ABSTRACTS 8175–8830

VOLUME 56 **DECEMBER 1953** NUMBER 672

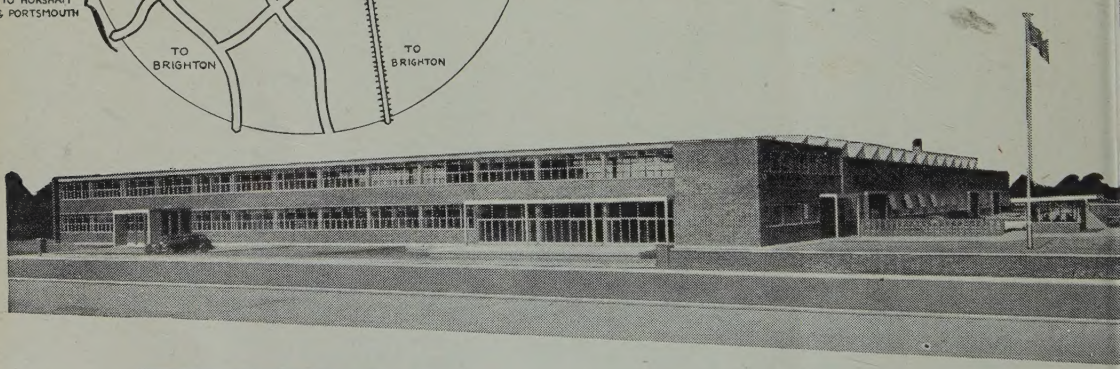


The quickest wa

TO SOLVE YOUR VACUUM PROBLEMS..

If you have a vacuum problem or need a vital vacuum component come and see us in our new factory and research centre at Crawley. We are little more than half an hour's train ride from London and more than ever can now provide "better vacuum service."

If you are interested in the latest methods of vacuum equipment manufacture and technique we shall be pleased to see you at Crawley.



New address for better vacuum service...

W. EDWARDS & CO. (LONDON) LTD.

MANOR ROYAL, CRAWLEY, SUSSEX

Telephone: Crawley 1500 : *Telegrams: Edcohivac Crawley.*

Principal Contents

DECEMBER 1953

		PAGE
1	MATHEMATICS	1049
2	ASTRONOMY. ASTROPHYSICS. GEODESY	1050
3	PHYSICS	1052
30.1	Fundamentals	1053
31	General mechanics. Mechanics of solids	1057
31.7	Mechanical measurements	1057
32	Mechanics of fluids	1058
32.6	Capillarity	1059
32.7	Molecular theory of liquids	1059
33	Mechanics of gases	1060
33.7	Molecular theory of gases	1061
34	Vibrations. Acoustics	1061
35	Optics. Radiation. Spectra	1064
36	Heat	1070
36.7/.8	Thermodynamics	1073
37	Electricity	1074
37.1	Theory. Electrons	—
37.2	Electrostatics. Dielectrics	1074
37.3	Electric conduction. Currents	1075
37.52	Electric discharges	1078
37.531	X-rays	1080
37.533/.534	Cathode rays. Positive rays	1080
37.54	Discharge tubes. Counters	1082
37.56/.58	Ionization. Thermionics	1084
37.591	Cosmic rays	1085
38	Magnetism	1089
38.3/.5	Electromagnetism. Electrodynamics	1099
38.56	Electromagnetic waves and oscillators	1099
38.6	Magnetic effects	1101
39.1	Molecular and atomic structure	1102
39.11	Theory of solid state	1102
39.13	Molecular structure	1103
39.15	Atomic structure. Nucleus. Isotopes	1105
39.16	Radioactivity. α-, β- and γ-rays	1107
39.17	Nuclear reactions	1109
39.18	Atom and molecular beams. Mesons. Neutrons	1112
39.2	Structure of solids	1114
39.3/.8	Elasticity. Strength. Rheology	1115
41	PHYSICAL CHEMISTRY	1116
41.11/.12	Phase equilibrium. Chemical reactions	1116
41.13	Electrochemistry	1117
41.14/.15	Photochemistry. Radiation chemistry	1117
41.18	Dispersions. Colloids. Adsorption	1118
41.2/.6	Chemical structure	1119
42.1/.7	Laboratory apparatus	1119
42.9	Chemical processes	1119
43/45	Chemical analysis	1120
48	CRYSTALLOGRAPHY	1120
48.7	Molecular and X-ray crystallography	1121
55	GEOPHYSICS	1125
51.5	Atmosphere. Meteorology	1125
57/59	BIOLOGY	1127
61	Medical science. Human physiology	1127
66/67	TECHNICAL MATERIALS	1128
77	PHOTOGRAPHY	1128

RELATED SUBJECTS CONTAINED IN SECTION B (ELECTRICAL ENGINEERING ABSTRACTS)

Electrical and magnetic measurements and instruments
Electronic relays and counters
Automatic control mechanisms
Applied electrochemistry
Photocells
Thermionic tubes
Cathode-ray tubes
X-ray tubes
Amplifiers
Radiocommunication
Mechanical engineering
Illumination

LIST OF JOURNALS

The following list supplements the List of Journals published with the January number of Volume 56 (1953). Reprints of the List of Journals can be obtained from the Institution of Electrical Engineers, Savoy Place, London W.C.2, price 2s. 0d. post free.

The addresses given are believed to be correct at the date of publication, but no responsibility can be accepted fo errors.

J. Inst. Polytech. Osaka City Univ.	*Journal of the Institute of Polytechnics, Osaka City University: Series A Physics.* Osaka.
Mitt. Max Planck-Inst. Phys. Stratosphäre	*Mitteilungen aus dem Max Planck-Institut für Physik der Stratosphäre* Weissenau bei Ravensburg. [Mainly extensions of articles published in shorter form in other journals.]

New Journals

Bull. sci. Cons. Acad. Yougoslavie	*Bulletin scientifique. Conseil des Academies de la RPF de Yougoslavie* B.P. 199, Ljubljana, Yugoslavia. Vol. 1, No. 1 dated *January*, 1953
Energetik	*Energetik.* Vetoshnȳ per., 2, Moscow 12. No. 1 dated 1953. [Incorporates *Promȳshlennaya Energetika* and *Rabochiĭ Energetik.*]

Notes

Bull. Inst. Nuclear Sci. "Boris Kidrich"	*Bulletin of the Institute of Nuclear Sciences "Boris Kidrich."* P.O. Box 522 Belgrade. Formerly *Recueil de Travaux de l'Institut de Recherches sur la Structure de la Matière.* Title changed commencing Vol. 3, 1953
Prom. Energ.	*Promȳshlennaya Energetika.* Incorporated in *Energetik* after No. 5, 1953

Errata

Abstr. 5454 (1953) line 1: *for* N. V. NOVOSIL'TSEV *read* N. S. NOVOSIL'TSEV.
Abstr. 6401 (1953) line 3: *for* J. H. OORT *read* J. OORT.
Abstr. 6455 (1953) line 5: *for* ϕ_P *read* ϕ_ρ.
Abstr. 6461 (1953) line 6: *insert* "all" *before* "gauge transformations."
Abstr. 7186 (1953) line 2: *for* C. O. MEUHLHAUSE *read* C. O. MUEHLHAUSE.

Corrections to Articles

Corrections have been published, as shown below, to the articles whose abstract numbers are given. Unless otherwise stated, the volume and page given refer to the journal named in the abstract, i.e. the journal in which the original article was published.

Abstr. 9108 (1950): **21,** 1607 (*Sept.*, 1953).
Abstr. 2159 (1953): **117,** 471 (*May*, 1953).
Abstr. 2310 (1953): **12,** *No.* 7–8, 423 (1953).
Abstr. 3341 (1953): **66,** 815 (*Sept.*, 1953).
Abstr. 5513 (1953): *No.* 44, 14 (*July*, 1953).
Abstr. 5646 (1953): *No.* 44, 14 (*July*, 1953).
Abstr. 6050 (1953): **8,** 569 (*July–Aug.*, 1953).
Abstr. 6349 (1953): **10,** *No.* 9, 460 (1953).
Abstr. 7018 (1953): *No.* 44, 14 (*July*, 1953).
Abstr. 7022 (1953): *No.* 44, 14 (*July*, 1953).
Abstr. 7426 (1953): **10,** 356 (*March*, 1953).
Abstr. 7503 (1953): **12,** No. 7–8, 424 (1953).

MATHEMATICS 51

513.76 : 537.534.72

Realization of special contact transformation with atic electromagnetic fields *in vacuo*. *See Abstr.* 58

513.813 : 530.12

75. Generalized Riemann spaces and general lativity. L. P. EISENHART. *Proc. Nat. Acad. Sci. .S.A.*, **39**, 546–51 (*June*, 1953).

The connection $\Delta^h_{ij} = \frac{1}{2}g^{hk}(g_{ik,j} + g_{kj,i} - g_{ij,k})$ is efined for a space with non-symmetric g_{ij}. A cond connection $\Gamma^h_{ij} = \Delta^h_{ij} + a^h_{ij}$ is introduced, the nsor a^h_{ij} being such that $g_{ij,k} = g_{hj}\Gamma^h_{ik} + g_{ih}\Gamma^h_{kj}$. arious tensor identities are established and related results used by Einstein (1950). R. A. NEWING

518.2

176. Tables of associated Legendre functions. olume I. [Tables des fonctions de Legendre ssociées.] *Paris: Editions Revue d' Optique* (1953) *n French.*

Associated function of the first kind, $P^m_n(\cos\theta)$. his first volume covers: n, $-0{\cdot}5(0{\cdot}1)10$; m, 0(1)5; , 0(1)90°.

518.5

177. A photomechanical wave analyser for Fourier nalysis of transient waveforms. J. DARBYSHIRE AND A. J. TUCKER. Note in *J. Sci. Instrum.*, **30**, 212 *June*, 1953).

Describes an analyser used over a period of years or sea waves [see Abstr. 2855 B (1946)]. The drum peed is controlled so as to decay exponentially with ime, and the instrument can be used to obtain the elative phases of two records as well as the mplitudes. N. CORCORAN

518.5 : 621.3.012

178. A calculating rule with special scales for the olution of right-angled vector triangles. P. NUCCI. *Elettrotecnica*, **40**, 302 (*June* 10–25, 1953) *In Italian.*

The rule consists of an upper and a lower scale oined by a cursor. Starting from the centre, the pper scale is ruled for $\log(1 + a^2)$ to the right and $\log(1 - a^2)$ to the left with $0 < a < 1$; the lower cale is graduated to give the square root of the upper ne. The rule is useful for solving impedance riangles; a is the ratio of the two given sides and the eading gives the corresponding ratio of the third. An additional scale gives $\cos\theta$ for $0{\cdot}01 < \sin\theta < 0{\cdot}1$. P. LINTON

518.5 : 621.317.79

8179. The application of sampling methods to analogue integrators. J. E. PATEMAN. *Elliott J.*, **1**, 110–12 (*May*, 1953).

Sampling-type integrators are considered under two headings. In the "series type," the integral is composed of equal contributions and these are counted; accuracies of 0·1% and 0·5% are claimed for the Miller circuit and the oscillating meter respectively. In the "rectangular" type of integrator, the integrand is accumulated at a fixed repetition rate; errors <0·1% are claimed for both the oscillating shaft with precision ratchet and for the rotating shaft with magnetic clutch; the author favours the gated clock pulse type which reduces the integration to a count of clock pulses, the latter being gated by rectangular pulses of width = integrand at the fixed sampling instants. T. J. REY

519.2 : 523.854.1

8180. Stochastic processes associated with random divisions of a line. A. RAMAKRISHNAN. *Proc. Cambridge Phil. Soc.*, **49**, *Pt* 3, 473–85 (1953).

A class of stochastic processes associated with points randomly distributed in a line of finite extension L, is considered. A general integral equation for the function representing the probability distribution of the stochastic variable under consideration is derived and solved by using the Laplace transform technique. Examples of the above class of processes are cited. In particular, the problem of the fluctuations in brightness of the Milky Way is discussed in detail. The results of Chandrasekhar and Münch in regard to this astrophysical problem are derived in a simple and direct manner. A.

519.2 : 537.542

8181. A stochastic problem relating to counters. A. RAMAKRISHNAN AND P. M. MATHEWS. *Phil. Mag.*, **44**, 1122–8 (*Oct.*, 1953).

The probability distribution function $\pi(n, t)$ of the number of registered events n in a time interval t for a counter in the case when the registered and unregistered events are followed by different dead times, is derived by using the method of product densities formulated in Abstr. 15 (1951). A.

519.2 : 621.391

8182. On the capacity of a discrete channel. I. Mathematical expression of capacity of a channel which is disturbed by noise in its every one symbol and expressible in one state diagram. S. MUROGA. *J. Phys. Soc. Japan*, **8**, 484–94 (*July–Aug.*, 1953).

Describes a general and concrete method of calculating the capacity in a noisy channel having one state which Shannon did not solve analytically. In order to express $H_x(y)$ concisely, the author introduces $H_x(y)$ characteristic equations, the solution of which characterizes the channel capacity, and the capacity problem is solved, taking into consideration whether the calculated probabilities of symbols are real or not. An analogy between capacity and rank is discussed and also the capacity when $H_x(y)$ characteristic equations have no solution. Numerical examples and a geometrical representation of capacity are described. A.

ASTRONOMY . ASTROPHYSICS . GEODESY 52

523.11

8183. Cosmology. W. H. McCrea. *Rep. Progr. Phys.*, **16**, 321–63 (1953).

The choice of treatment in this review is influenced by the nature of a number of other existing reviews of cosmology. Observational results are here summarized only briefly because, for the most part, the results obtained after the appearance of these other reviews have not yet been published. Cosmological theories fall into two main categories according as they start from postulates concerning the universe as a whole and seek to deduce physical laws, or start from postulated laws and construct model universes compatible with such laws. Of the cosmologies here reviewed, those of kinematic relativity and of the steady-state theory belong to the first category, while those of newtonian theory and of general relativity theory and its extensions belong to the second. To a considerable extent it proves possible to imitate the procedures of all these theories for the case of material moving in classical space–time. In this way a largely unified presentation is obtained and comparison of the theories is facilitated. At the same time the standard procedures of the theories are also indicated in the review. In comparing the theoretical models with the actual universe emphasis is laid upon the broad aspects about which there is a considerable measure of agreement. The possibilities that have been investigated of relating the theories to the problem of the origin of the chemical elements and to the problem of the origin and evolution of the galaxies are mentioned. The whole subject is in a somewhat inconclusive state, and the main purpose of the review is to describe the lines of thought being pursued in current work. 36 references. A.

523.161 : 533.6.011

8184. A note on the unsteady motion of a compressible fluid. D. C. Pack. *Proc. Cambridge Phil. Soc.*, **49**, *Pt* 3, 493–515 (1953).

A solution is found in closed form for the one-dimensional motion of an ideal, inviscid and isentropic gas with ratio of specific heats $(2m + 3)/(2m + 1)$, m being any positive integer, when the gas is supposed to start from rest with an inhomogeneous temperature distribution. An example is given which is of interest in the study of interstellar gas clouds. A cloud is assumed to be initially at rest in contact with a vacuum; the Riemann invariant r is assumed to increase linearly for a finite distance into the cloud (from zero at the surface), beyond which it remains constant. The r-characteristics from the inhomogeneous strip meet simultaneously in the distance-time plane at a point of the gas surface; the surface does not move until this happens, when it acquires instantaneously a finite non-zero velocity. A numerical estimate is made of the time during which the surface remains at rest for an actual gas cloud under the above conditions. In the subsequent development the gas motion takes the form of a growing simple wave. A.

523.165

8185. The identification of radio sources. D. W. Dewhirst. *J. Brit. Astron. Assoc.*, **63**, 263–6 (*Jul* 1953).

523.1

8186. Cosmic origin of radiation at radio f quencies. F. Hoyle. Letter in *Nature* [*London*] **17** 296–7 (*Aug.* 15, 1953).

A discussion of the two major difficulties inher in suggesting that the radio-emission from su sources as those recently observed in Cygnus a Cassiopeia is of purely thermal origin. The first that of providing adequate amounts of radiation build up black-body radiation at metre wavelengt the second, that of explaining why the same proc will not produce a similar energy maximum in t cm band. Classical treatment of the problem fails provide sufficient thermal radiation as a result electron–proton encounters; and the reason for th is shown to be the assumption of a random *ab ini* particle distribution. If the positions of protons a electrons are not so distributed because of a separati of charge, then the rate at which radiation is emitt can rise to the requisite magnitude. Moreover t strong dependence of this rate on frequency explai why a parallel energy output is not observable centimetre wavelengths. D. R. BARB

523

8187. Photoelectric measurements of solar magnet fields. K. O. Kiepenheuer. *Astrophys. J.*, **11** 447–53 (*May*, 1953).

A photoelectric instrument is described for th detection of small Zeeman effects, based on th measurement of the total polarization in the wing the Fe line λ 5250·218. This instrument, whe attached to the grating spectrograph of the Mou Wilson 150 ft solar tower, gave no indication of general field of the sun (spring, 1951). The upp limit set is about 1 gauss for the longitudinal fiel Certain patches are observed having a field of a fe gauss but containing no sunspots. These fields sho a fine structure indicating the occurrence of pea fields of more than 20 gauss, even outside the spo belts. The results presented have a preliminar character.

523.72 : 523.7

8188. Results of observations of an annular eclips of the sun made on 169 Mc/s and 9350 Mc/s. E. Blum, J. F. Denisse and J. L. Steinberg. *Ann Astrophys.*, **15**, *No.* 2, 184–98 (1952) *In French.*

Observations of the annular solar eclipse of 195 September 1, made in the French Sudan are reporte On 3·2 cm, the distribution of brightness across th disk showed some limb-brightening, in agreemer with a theoretical curve based on a strong temperatur gradient in the chromosphere. The occultation of a area active on this wavelength was simultaneous wit the visual occultation of a sunspot, showing that th active area, of temperature $\sim 6 \times 10^{5°}$ at 3·2 cm, wa localized about the visible spot. The mean diamete of the solar disk at 178 cm was $\sim 35\%$ greater tha the visual diameter, but showed a marked departur

ɔm circular symmetry in the sense of an equatorial ameter larger than the polar diameter.

M. W. OVENDEN

523.72 : 523.74

89. On an asymmetry of the radio radiation of the n observed on decimetric wavelengths. E.-J. BLUM. *.R. Acad. Sci.* [*Paris*] **237,** 135–7 (*July* 15, 1953) *In ·ench.*

An analysis of published observations of the sun n wavelengths ~50 cm by Christiansen, *et al.*, anier and Laffineur, *et al.*, shows an asymmetry of e type found by eclipse observations at $\lambda = 178$ cm Blum, Denisse and Steinberg (preceding abstract). tentative model for the solar disk consistent with ese different sets of observations is derived.

M. W. OVENDEN

523.72 : 523.74

190. On the distribution of brightness across the n at a frequency of 9350 Mc/s. I. ALON, J. ARSAC ND J.-L. STEINBERG. *C.R. Acad. Sci.* [*Paris*] **237,** 00–2 (*July* 27, 1953) *In French.*

The distribution is obtained from observations nade with a variable-spacing interferometer system. wo models of the distribution of brightness across ne disk, compatible with the interferometric and clipse observations, are given: both show marked mb brightening, and one shows a secondary maxi- um of brightness at the centre of the disk.

M. W. OVENDEN

523.72 : 537.56

Collisional effects and the conduction current in an onized gas. *See Abstr.* 8478

523.72 : 537.591 : 551.510.535

On the longitude effect of a corpuscular stream from ne sun. *See Abstr.* 8813

523.746

191. A relationship between geomagnetic disturbance and the distribution of sunspots. U. BECKER. *Astrophys.*, **32,** 195–9 (*Aug.*, 1953) *In German.*

From observations made in years near sunspot minimum (1946–50), it is found that the central meridian passage of symmetrical spot-pairs (N and hemisphere) is followed 2–3 days later by minimum magnetic activity as indicated by *K*-indices. Also, or small geomagnetic disturbances ($\Sigma K_1 \leqslant 16$), max. pot formation occurs in both hemispheres at helio- graphic long. 40° W. D. R. BARBER

523.76

192. Instability of thermal fields. E. N. PARKER. *Astrophys. J.*, **117,** 431–6 (*May*, 1953).

The field equation for the kinetic temperature, T_ϵ, s considered in the case of a gas composed of hydrogen-like atoms. If the atoms are largely onized and free-free emission does not predominate, he thermal field is unstable unless stabilized by a trongly temperature-dependent supply of energy. The possibility of interpreting much of the thermal ctivity in the solar atmosphere as due to such nstability is discussed. A.

523.774

3193. Photometry of Fraunhofer lines with the Lummer plate applied to (measurement of) the centre–edge variation of the Na–*D* lines. W. PRIESTER. *Z. Astrophys.*, **32,** 200–50 (*Aug.*, 1953) *In German.*

A detailed description is given of the use of a Lummer–Gehrcke interferometer with the Göttingen solar spectrograph to photograph high-resolution interference-spectra of the D_1 and D_2 Fraunhofer lines. Subsequent photometry of the photographic density profiles enables direct comparison between observed centre-to-edge profile of each line, after being freed from instrumental effects, and a theoretical profile based on data derived from the solar model of Vitense (1950). D. R. BARBER

523.84 : 523.852

8194. Orion variables and turbulence in the Orion nebula. R. KIPPENHAHN. *Z. Astrophys.*, **32,** 185–94 (*Aug.*, 1953) *In German.*

Rapid magnitude fluctuations in certain Orion variable stars cannot be explained by equally rapid changes of stellar absorption; but most probably these are due to localized turbulence of the interstellar dust in which these stars are immersed. D. R. BARBER

523.854.1 : 519.2

Stochastic processes associated with random divisions of a line. *See Abstr.* 8180

523.872 : 523.852

8195. Collisional excitation of hydrogen in a gaseous nebula. J. W. CHAMBERLAIN. *Astrophys. J.*, **117,** 387–98 (*May*, 1953).

Collisional excitation of hydrogen may be important in a number of planetary and diffuse nebulae where the electron temperature is considerably above 10 000°K. Conceivably, sufficient mechanical energy could be supplied to a nebula to keep its kinetic temperature high and support its radiation. Accordingly, this paper investigates the emission-line spectrum that would be produced by optically thin and optically thick nebulae that are excited primarily by inelastic electron-hydrogen collisions. The method of statistical equilibrium is used to derive an expression for b_n, the factor inserted in the combined excitation-ionization equation for the nth level of hydrogen to take account of departures from thermodynamic equilibrium. With these b_n's the Balmer decrement and the amount of ionization are computed for electron temperatures of 10 000°, 20 000° and 40 000°K. Collisional cross-sections based on the Born approximation are used. Equations are developed for calculating the Balmer decrement when radiation and collisions are both important and when the electron density and temperature of the nebula and the temperature and dilution factor of the stellar radiation are assumed. A numerical example, which illustrates the relative importance of the two types of excitation under certain specified conditions, is presented. A.

523.872 : 523.852

8196. The excitation of the Network Nebulae. J. W. CHAMBERLAIN. *Astrophys. J.*, **117,** 399–406 (*May*, 1953).

The apparent absence of an exciting star for the Network Nebulae in Cygnus has given rise to speculations on a source of mechanical energy for these objects. In this case collisional excitation of hydrogen would be important, and the relative intensities of the

emission lines would differ from those resulting from excitation by stellar illumination. This paper considers the spectrum of the Network Nebulae from the standpoints of collisional and radiative excitation, in an effort to determine which theory gives the more consistent picture. The observations consisted of direct photographs made with various combinations of filters and emulsion types that isolated emission lines of oxygen and hydrogen. Surface brightnesses were determined from photometric comparisons, allowing the emission in erg/cm^3 sec to be estimated. The observational data, when interpreted by collisional theory, give a consistent picture for an optically thick nebula at roughly 20 000°K. A similar interpretation can be obtained with the radiative theory. Hence a need for further observations is emphasized. The various arguments for both types of excitation are summarized. Although the nova-shell hypothesis does not seem acceptable, there is some evidence that hydrogen is at least partially excited by mechanical energy. On the other hand, hot stars in the near-by Milky Way may contribute sufficient radiation to keep the nebulae ionized. A.

523.877

8197. The outer atmospheres of some Be stars. G. R. BURBIDGE AND E. M. BURBIDGE. *Astrophys. J.*, **117**, 407–30 (*May*, 1953).

Coudé spectra have been analysed. Line profiles and equivalent widths have been measured. The hypothesis is put forward that the difference between the hydrogen absorption-line profiles in these star and in normal B stars of the same luminosity class due mainly to the effect of electron scattering in th outer parts of the atmospheres of the Be star together with the distortion due to different rotationa velocities. The results lend support to this hypothes and enable an estimate to be made of the depths c the electron-scattering regions. The Balmer emissio line profiles and equivalent widths have been measure The equivalent widths have been used to obtain rough estimate of the physical character and dime sions of the emitting regions. For the case of 11 Car it has been possible to construct a rough model whic has a thin scattering layer lying over the polar regio of the photosphere and a thick layer having a radiu of several times the stellar radius lying outside th photosphere near the equatorial zone. The effect c continuous absorption in the outer atmosphere i briefly discussed. A

523.877 : 523.16

8198. A case of gaseous accretion. K. N. DODD *Proc. Cambridge Phil. Soc.*, **49**, *Pt* 3, 486–92 (1953).

The isothermal flow of gas past a gravitating point sink has been studied for four values of the undis turbed gas velocity, all of which are supersonic. Fro these studies, estimates have been made of the rate of accretion of an isothermal gas by a star movin with a supersonic velocity. These estimates are o the same order as those obtained by earlier worker who used simpler mathematical models. A

PHYSICS 53

53.08 : 530.162

8199. Fluctuation theory in physical measurements. C. W. MCCOMBIE. *Rep. Progr. Phys.*, **16**, 266–320 (1953).

An attempt is made to give a coherent, elementary account of the ways in which fluctuation theory has been applied to some of the simpler types of physical measurement. Uncertainties in measurements involving suspended systems are discussed on the basis of simple correlation function arguments, and consideration is given to the methods of measurement appropriate when there are various practical limitations on the parameters of the suspended system. There follows an elementary development of the mathematical and physical considerations usually employed in treating fluctuations in linear measuring instruments: remarks on the status of the random force method as applied to equilibrium systems are included. The circumstances under which there is an absolute limit to the attainable accuracy are discussed. It is shown that, in the case of measurements with a suspended system, feedback may enable these limits to be attained with a convenient measurement procedure. An account is given of various approaches to the calculation of the limits of accuracy in measurements with radiation detectors. Finally some elementary results are established concerning the optimum characteristics of an instrument used to follow a varying signal in the presence of noise. 78 references. A.

53.08

8200. Extent of the international system of measure ment. E. PERUCCA AND F. DEMICHELIS. *Helv. phys Acta*, **26**, *No.* 3–4, 329–48 (1953) *In French.*

The basic relations between physical quantities s choosing as fundamental independent quantities s length, time, mass, current, temperature and luminous intensity with units metre (m), second (s), bes (b), ampere (A), celsius (°C) and candela (cd) are recalled The principle of coherence, the MKSA and CIM systems, derived units, rationalization and suggestions for improvement to obtain a single all-embracing system of measurement, put forward by various authors, including in particular Demichelis, *Radiologica medica*, 35, *No.* 12, 1949, and Perucca [Abstr 3259 (1952)] are discussed. S. WEINTROUB

53.081

8201. Rationalization in the light of quantity equations. M. BREZINŠĆAK. *Physica*, **19**, 599–604 (*July*, 1953).

It is stated that so-called rationalization, as met in common practice, is to be considered as a transition from the numerical equations of electromagnetism, adjusted to CGS electromagnetic, electrostatic and "mixed" Gauss units, to quantity equations, which are valid for all systems of units. Only a few quantities of minor importance, viz. the magnetic polarization and magnetic susceptibilities and the corresponding electric quantities are to be changed in this transition. A.

FUNDAMENTALS 530.1

530.12

8202. The spinor connection in the unified Einstein theory of relativity. V. HLAVATÝ. *Proc. Nat. Acad. Sci. U.S.A.*, **39,** 501–6 (*June*, 1953).

Local spinor spaces $S_3(P)$ are defined at points P of the space X_4 of unified theory. The spaces $S_3(P)$ are superposed on a three-dimensional projective space Σ_3 which is defined to be the spinor space attached to X_4. The set of connections in Σ_3 is investigated. R. A. NEWING

530.12

8203. Connections between Einstein's two unified theories of relativity. V. HLAVATÝ. *Proc. Nat. Acad. Sci. U.S.A.*, **39,** 507–10 (*June*, 1953).

The 1945–48 theory was expressed in terms of the complex tensor ${}^*g_{\lambda\mu} = h_{\mu\lambda} + ik_{\lambda\mu}$, and the 1950 theory in terms of the real non-symmetric $g_{\lambda\mu} = h_{\lambda\mu} + k_{\lambda\mu}$. The relationship between the corresponding connections ${}^*\Gamma^{\nu}_{\lambda\mu}$ and $\Gamma^{\nu}_{\lambda\mu}$ is discussed. R. A. NEWING

530.12

8204. Pure radiation fields with central symmetry in general relativity theory. A. K. RAYCHAUDHURI. *Z. Phys.*, **135,** *No.* 2, 225–31 (1953) *In German.*

From a consideration of boundary conditions for spherically symmetric solutions of the field equations it is concluded that radiation fields in an otherwise empty space are not possible in the absence of singularities representing sources of radiation. It is concluded that it is not possible for an isolated spherical star to radiate away its whole mass. R. A. NEWING

530.12

8205. The ten general integrals of the equations of motion in the mechanics of the special theory of relativity. H. SAILER. *Acta phys. Austriaca*, **7,** *No.* 2, 155–63 (1953) *In German.*

The 3 first and 3 second centre-of-mass integrals, the 3 surface integrals and the energy integral for a system of interacting particles are derived from the invariance of the equations under the Lorentz transformations. W. J. SWIATECKI

530.12

8206. A rotationally symmetric solution in the general theory of relativity. A. PAPAPETROU. *Ann. Phys. [Leipzig]* **12,** *No.* 4–6, 309–15 (1953) *In German.*

An exact, axially symmetric solution of the field equations is derived. The physical interpretation shows that it describes the field of a source with finite extension and angular momentum but vanishing total mass. W. J. SWIATECKI

530.12 : 513.813

Generalized Riemann spaces and general relativity. *See Abstr.* 8175

530.12 : 523.11

8207. On the possibility of a new static cosmological model. II. R. L. BRAHMACHARY. Note in *Naturwissenschaften*, **40,** *No.* 11, 313–14 (1953) *In French.*

For Pt I, see Abstr. 5848 (1953). The line element corresponding to an electrified substratum is discussed for a uniform distribution in a Euclidean universe and for a distribution of low density in a curved universe. R. A. NEWING

530.12 : 536.7

8208. Thermodynamics in general relativity. E. C. G. STUECKELBERG AND G. WANDERS. *Helv. phys. Acta*, **26,** *No.* 3–4, 307–16 (1953) *In French.*

Mechanical and thermodynamic laws expressed in the form $\Theta^{\beta}_{\alpha;\,\beta} = 0$, $n^{\beta}_{A;\beta} = 0$, $s^{\alpha}_{;\,\alpha} - i = 0$ where $i \geqslant 0$ and s^{α} is an entropy current, are assumed to be related by equation $\varepsilon v^{\alpha}\Theta^{\beta}_{\alpha;\,\beta} + \sum_A \mu_A n^{\beta}_{A;\,\beta} + T(s^{\beta}_{;\,\beta} - i) = 0$. The requirement that this equation shall be satisfied identically is used to determine the symmetric tensor $\Theta^{\alpha\beta}$ and the quantities n^{α}_A, s^{α} and i. The investigation provides an extension to general relativity of Leaf's results [Abstr. 55 (1952)] for the special theory. R. A. NEWING

530.12 : 538.11

8209. A unified field theory of gravitation and electromagnetism. G. STEPHENSON AND C. W. KILMISTER. *Nuovo Cimento*, **10,** 230–5 (*March*, 1953).

A unified theory is developed from the metrical properties of a non-Riemannian space-time structure S_4. The equations of the geodesics in S_4 are non-minimal curves in a Riemannian space R_4 and are identical with the relativistic equations of motion of a test particle moving in a gravitational and electromagnetic field. The Gaussian curvature of the geodesic surface is discussed and the scalar which arises is used to form a Lagrangian, from which the field equations are derived. These field equations are the usual Einstein gravitational equations and Maxwell electromagnetic equations, together with interaction terms, and imply equations of motion which are consistent with those obtained from the geodesic equations. The affine properties of the non-Riemannian space are briefly discussed. A.

530.145

8210. Derivation of quantum theory from a classical model. II. W. WEIZEL. *Z. Phys.*, **135,** *No.* 3, 270–3 (1953) *In German.*

The considerations of a previous paper [Abstr. 5849 (1953)] are extended to the case of an external magnetic field. W. A. HEPNER

530.145

8211. The structure of the domains of magnitude [Grössenbereich] of classical and quantum mechanics. G. FALK. *Z. Phys.*, **135,** *No.* 4, 431–72 (1953) *In German.*

The non-relativistic mechanics of closed systems is reviewed and an axiomatic description of the structure of matter is developed. The latter is framed in terms of a commutative ring of formal power-series, in which a certain bracket operation is defined. This ring, and its properties, leads to the introduction of the Heisenberg-ring, which is a non-commutative free polynomial ring, in which there are no relations and no bracket operation is defined. Quantum mechanics is described in terms of this ring, and in this description the ideal structure of the ring is important. Non-closed systems are then studied, and the modification of the theory brought about by the introduction of spin is described. Later, the structure of relativistic classical and quantum mechanics is investigated, and application is made to the theory of elementary particles. L. S. GODDARD

530.145

8212. The quantum mechanical equations of motion and the commutation relations. VACHASPATI. Letter in *Proc. Phys, Soc.* [*London*] *A*, **66,** 657–8 (*July*, 1953).

It is shown that the commutation rule $[q, p] = i$ may be derived by postulating invariance under unitary transformations. P. M. DAVIDSON

530.145

8213. A note on the quantum dynamical principle. J. SCHWINGER. *Phil. Mag.*, **44,** 1171–9 (*Oct.*, 1953).

It is shown that commutation relations are derived consistently from the quantum dynamical principle, for systems obeying first-order equations of motion [see Abstr. 3853 (1953)]. A.

Schwinger's dynamical principle. W. K. BURTON AND B. F. TOUSCHEK. *Ibid.*, 1180–1.

A comparison is made of the methods applied by Schwinger and by the authors to the derivation of commutation relations for systems whose equations of motion are of the first order in the time derivatives. A.

Comment on the above note. J. SCHWINGER. *Ibid.*, 1181.

530.145

8214. On Lagrangian formalism. K. NISHIJIMA. *Progr. theor. Phys.*, **8,** 401–15 (*Oct.*, 1952).

The differences between Lagrangian and Hamiltonian formalisms are discussed through the concept of chronological ordering operators, thereby keeping close correspondence to Feynman's path integral. A method of deriving commutation relations without referring to Hamiltonian formalism is presented. A.

530.145

8215. Selection rules imposed by charge conjugation. L. MICHEL. *Nuovo Cimento*, **10,** 319–39 (*March*, 1953).

A systematic study is made of the invariance of field theories under charge conjugation in order to indicate all possible selection rules due to charge conjugation alone or combined with charge symmetry or charge independence. It is shown that when isotopic spin formalism is used, invariance under charge conjugation corresponds to conservation of isotopic parity. A.

530.145

8216. Construction of conservation equations for non-local field theories. C. GREGORY. Letter in *Phys. Rev.*, **91,** 770 (*Aug.* 1, 1953).

For field equations involving the operator fields and displacement operator in an arbitrary way. G. E. BROWN

530.145

8217. The commutation laws in the theory of quantized fields. M. CINI. Letter in *Nuovo Cimento*, **9,** 1025–8 (*Oct.*, 1952).

The commutation rules for field quantities at different space-time points are derived in the framework of Schwinger's theory [Abstr. 6731 (1951)]. The relation with Peierls' rule [Abstr. 7934 (1952)] is discussed. G. FIELD

530.145

8218. Convergence in the intermediate representation. J. HAMILTON. *Proc. Cambridge Phil. Soc.*, **49,** *Pt* 4, 642–9 (1953).

It is shown that for the quantized ϕ^3 field the series expansions for intermediate representation fiel operators are convergent for summation over a graphs except those containing self-energy and verte parts. The method used does not permit an investiga tion of the self-energy and vertex parts.

530.14

8219. The Yang–Feldman formalism and boun states. W. ZIMMERMANN. *Z. Phys.*, **135,** *No.* 473–82 (1953) *In German.*

The case of electrons in a time-independent externa electromagnetic field is taken, to investigate th possible application of the Yang–Feldman formalis to the quantization of non-local field equations fo bound states. It is found that neither the fiel operators nor their commutation relations can b uniquely determined. G. FIEL

530.14

8220. A general theory of the second quantizatio methods. M. SCHÖNBERG. *Nuovo Cimento*, **1** 697–744 (*June*, 1953).

It is shown that the second quantization method are a general mathematical technique applicable t formalisms involving linear equations of change differential with respect to the time variable. Th ordinary second quantization formalism for systems c bosons or fermions, and the "second quantization" of the classical theory developed by the author ar obtained as particular cases of the general methods There are several ways of applying the second quanti zation methods to the same linear problem, whic lead to different formalisms. A very simple kind o second quantization is applied to the Schrödinge equation of an arbitrary mechanical system in orde to develop a new treatment of the statistical quantum mechanics (the Gibbs second quantization). In thi way a straightforward method of introducing th Gibbs ensembles and grand ensembles is obtained The entropy is discussed with the Gibbs secon quantization. Some ergodic theorems of the genera second quantization and the quantum mechanics ar derived. A

530.145 : 530.16

8221. Application of second quantization methods t the classical statistical mechanics. II. M. SCHÖNBERG *Nuovo Cimento*, **10,** 419–72 (*April*, 1953).

The classical mechanics of indistinguishable particles discussed in Pt I [Abstr. 7470 (1953)] is further developed. The mechanical foundations of thermo dynamics are discussed with the classical wave theory and the "quantized" fields in phase space. It is shown that the formalism eliminates automatically the Gibbs paradox. The classical statistics is treated with the Gibbs–von Neumann method and also by a generalized form of the Boltzmann method which takes into account the interactions. The introduction of finite cells in phase space leads to formulae similar to those of the quantal statistics for free particles, but no more so for interacting particles. The statistical treatment of the "quantized" field in phase space leads imme diately to the canonical grand ensemble. It is shown that the theory of the "quantized" field in phase space can be derived from the theory of a "non quantized" field in phase space, in which there are only continuous distributions of matter, by a proce dure of "quantization" altogether similar to that of

e quantum theory of fields, but not involving the anck constant, or any other universal constant. he "non-quantized" field in phase space corresponds a theory less accurate than classical mechanics d gives an approximation of the same kind as the olecular chaos hypothesis of the kinetic gas theory, contains both the dynamics and the heat theory of a ntinuous medium. A new derivation of the Boltz- ann equation involving a special kind of time erage is given and a similar equation is established r the two particle distribution function. A.

530.145

222. The effect of damping on radiative corrections electron scattering and the problem of infra-red tastrophe. R. C. MAJUMDAR AND A. N. MITRA. *rogr. theor. Phys.*, **8**, 479–92 (*Oct.*, 1952).

The reaction of radiation on the scattering of ectrons with radiative corrections is treated on the asis of covariant theory of radiation damping. It shown that the u.v. divergences are removed by the sual process of mass and charge renormalizations; nd the i.r. divergence, which still persists in the cond-order corrections to radiationless electron attering is exactly compensated by the corresponding ivergence occurring in scattering with the emission f radiation. The interaction Hamiltonian for the attering processes is given after Feynman–Dyson rmalism; also the covariant formulation of radiation amping and scattering cross-sections, and the i.r. ivergences involved in electron scattering are iven. A.

530.145

223. Radiative corrections to the scattering of lectrons by electrons. A. AKHIEZER AND R. POLOVIN. *Dokl. Akad. Nauk SSSR*, **90**, *No.* 1, 55–7 (1953) *In Russian.*

The scattering of electrons by electrons is calculated o fourth order (inclusive of α^2 effects). In the non-elativistic region the radiative corrections to the Møller scattering tend to zero with electron velocity. n the relativistic region and for scattering angles ν atisfying $p \sin \nu/2 \simeq mc$ or $p \cos \nu/2 \simeq mc$, radiative orrections are of order α of the main effect. An xplicit expression for the latter case is given.

G. E. BROWN

530.145

3224. On the question of radiation by fast electrons n a magnetic field. A. A. SOKOLOV, N. P. KLEPIKOV AND I. M. TERNOV. *Dokl. Akad. Nauk SSSR*, **89**, *No.* 4, 665–8 (1953) *In Russian.*

The solution of Dirac's equation in a uniform magnetic field is written down and the energy radiated in a transition from an initial state l to a final state l' is calculated assuming $l-l' \ll l$. The resulting correction to the classical radiation formula (to 1st order in $\hbar$) is a factor $\{1-(55\sqrt{3}/16)(\hbar/mcR)(E/mc^2)^2\}$, where R = radius of classical orbit, E = electron energy. W. J. SWIATECKI

530.145

8225. Differential conservation laws in non-local field theories. J. RZEWUSKI. *Nuovo Cimento*, **10**, 784–802 (*June*, 1953). Shorter version, *ibid.*, 182–5 (*Feb.*, 1953).

Investigates to what extent conservation laws are satisfied in non-local field theories. First it is shown from the invariance of the action integral with respect to gauge transformations of the first kind, translations and rotations of space-time there follow the integral conservation laws. These integral laws express that certain functionals of a space-like surface σ have equal values at the boundaries σ_1 and σ_2 of the domain of space-time considered in the problem. These functionals have the disadvantage of being not constant in the region between σ_1 and σ_2. Another disadvantage is, that they do not correspond with the local charge, momentum and angular momentum. It is shown further, that starting with the Euler–Lagrange field equations it is possible to construct other functionals of σ being constant throughout the region (σ_1, σ_2) and satisfying at the same time the correspondence principle. These functionals may, therefore, be interpreted as the total charge, momentum and angular momentum of the non-local system. The integral conservation laws follow from the differential laws if the condition of invariance with respect to the three above types of transformations is satisfied. The general considerations are illustrated on a simple example of a non-local field theory. A.

530.145

8226. Non local interactions—comparison between various formulations. R. ASCOLI. *Nuovo Cimento*, **10**, 745–53 (*June*, 1953) *In Italian.*

Compares the principal formulations so far proposed to introduce the idea of non-local interactions, showing that they may be comprised in the same general formulation as particular cases. A.

530.145

8227. On the solution of the Dirac–Corben equation. A. LOINGER. Letter in *Nuovo Cimento*, **9**, 855–6 (*Sept.*, 1952) *In Italian.*

The most general solution of the equation is developed from the known solution of the Dirac equation. L. S. GODDARD

530.145

8228. Physical equivalence of the equations of Dirac–Corben and Dirac. E. BELLOMO AND A. LOINGER. Letter in *Nuovo Cimento*, **9**, 1240–1 (*Dec.*, 1952) *In Italian.*

Using the result of the previous abstract it is shown that physical theory based on the Dirac–Corben equation may be considered as a modified representation of the theory based on the Dirac equation.

L. S. GODDARD

530.145

8229. A note on the application of Schwinger's variational principle to Dirac's equation of the electron. H. E. MOSES. *Quart. appl. Math.*, **11**, 111–18 (*April*, 1953).

For a plane electron wave incident on a potential, the scattered wave is expressed as a sum of outgoing spherical waves. The amplitudes of the outgoing waves are put in a form suitable for calculation by use of Schwinger's variational principle. G. E. BROWN

530.145

8230. Connection between fusion theory of bosons and nonlocal field theory. S. WATANABE. Letter in *Phys. Rev.*, **91**, 771 (*Aug.* 1, 1953).

Starting from de Broglie's theory of fusion the author demonstrates a method of deriving non-local

field equations for pseudoscalar and vector fields from a relativistic two-body spinor wave equation. G. FIELD

530.145

8231. On the self-stress. Y. TAKAHASHI AND H. UMEZAWA. *Progr. theor. Phys.*, **8**, 193–204 (*Aug.*, 1952).

The reason why the difficulty pointed out by Pais [Abstr. 3753 (1950)] arises is analysed by general discussion independent of any approximation for the self-stress of an arbitrary elementary particle interacting with arbitrary fields. To do this, the Pais–Epstein–Sawada formula is generalized for the system with more intricate interaction. The difficulty due to a process of the vacuum polarization type, on account of which the non-vanishing self-stress has been postulated, is also discussed. A.

530.145

8232. Some consequences of gauge invariance. M. KAWAGUCHI AND N. MUGIBAYASHI. *Progr. theor. Phys.*, **8**, 212–20 (*Aug.*, 1952).

A simple theorem is stated to expand the matrix element for a process concerning any number of photons or external electromagnetic fields into independent gauge invariant terms. It turns out that the number of such terms is uniquely determined by the initial and final states of the process, regardless of the intermediate states and the type of interaction. There are, for example, 4, 14 and 10 independent gauge invariant terms for the production of spin 0 and 1 mesons by photons and the Compton scattering, respectively. Some of the absolute selection rules for meson decays can be also derived from this gauge invariant expansion theorem. A.

530.145

8233. On the quantum theory of wave fields. B. T. GEĬLIKMAN. *Dokl. Akad. Nauk SSSR*, **90**, *No.* 3, 359–62 (1953) *In Russian.*

A meson field (scalar or pseudoscalar) in strong coupling with nucleons is considered. The meson field is expressed as the sum of a large classical part, satisfying a zero-order equation, and a small operator part, which is treated as a perturbation. Conditions for stable isobars and an equation describing meson scattering are given. G. E. BROWN

530.145

8234. Relativistic quantum dynamics of a system of interacting particles. J. RZEWUSKI. Letter in *Nuovo Cimento*, **10**, 90–3 (*Jan.*, 1953).

The *S*-matrix for a relativistic system of interacting particles is derived from an action integral containing a general type of interaction function. G. FIELD

530.145

8235. Non-adiabatic treatment of nucleon pion scattering. S. FUBINI. *Nuovo Cimento*, **10**, 564–72 (*May*, 1953).

The Tamm–Dancoff non-adiabatic method is applied to the study of nucleon-pion scattering. An integral equation is obtained. It is resolved, making use of some approximations, getting numerical results in satisfactory agreement with experiment. The existence of an isobaric state of the nucleon with spin 3/2 and isotopic spin 3/2 is also deduced. A.

530.1

8236. Three-particle Coulomb problems. FRÖNSDAL AND A. ORE. *Physica*, **19**, 605–10 (*Ju* 1953).

It is found that information concerning dynamic stability and inter-particle separation of singly-charg 3-particle Coulomb systems in general is an automat result of a rational choice of units of length and energy. This is true to the extent to which the groun states of the numerous systems of this kind a describable in terms of wave functions of the inte particle distances of attractive pairs of particles onl

530.1

8237. Radiative corrections to nuclear forces pseudoscalar theory. K. A. BRUECKNER. Letter *Phys. Rev.*, **91**, 761 (*Aug.* 1, 1953).

The bound-state Bethe–Salpeter equation is solv exactly, with the kernel in the zeroth approximati (to order g^2). Radiation corrections to the nuclec propagation functions in the adiabatic approximati are then found to discourage nucleon pair formation G. FIEL

530.1

8238. Repulsive core and charge independence. E. SALPETER. *Phys. Rev.*, **91**, 994–6 (*Aug.* 15, 1953).

In an earlier paper Schwinger [Abstr. 5509 (1950) derived expressions for the effective strengths of th neutron-proton and proton-proton interactions i the singlet *S* state. In this paper an equivale analysis is carried out for nuclear potentials whic have a repulsive core. It is shown that for co radii of more than about $0{\cdot}3\times10^{-13}$ cm the effe of the magnetic interaction is decreased and th difference between the *n-p* and *p-p* interactions increased. Numerical values of the discrepancy a given for different core radii. A

530.14

8239. Modified propagation functions in perturba tion theory. A. SALAM. *Proc. Cambridge Phil. Soc* **49**, *Pt* 4, 638–41 (1953).

Modifications to the Feynman propagatio functions S_F and D_F are suggested in order to dea with field theoretic problems involving the presence i the initial and the final states, of free fermions o bosons, having all values of momentum (and energy within a certain specified range. A

530.14

8240. Quantum mechanics of rigid electrons and th Lamb shift. L. WALDMANN. Note in *Z. Naturforsch* **8a**, 329–30 (*May*, 1953) *In German.*

Passing from Lorentz's equation of motion of rigid electron to quantum mechanics, an expressio for the Lamb shift is inferred. W. A. HEPNE

530.14

8241. On inverse perturbation. A. CUNLIFFE AN R. N. GOULD. Letter in *Phil. Mag.*, **44**, 785–7 (*July* 1953).

It is shown that under certain conditions it practicable to calculate the perturbing operator an the perturbed eigenfunctions from a knowledge of th perturbed eigenvalues. P. M. DAVIDSO

530.145

8242. On the formulation of quantum mechanics associated with classical pictures. T. TAKABAYASI. *Progr. theor. Phys.*, **8**, 143–82 (*Aug.*, 1953).

By re-expressing the generalized Schrödinger equation in its co-ordinate representation in terms of amplitude and phase of the state vector, a quantum-mechanical change of a system can be made to correspond to an ensemble of classical motions of the system to which is added some internal potential. This ensemble may be taken as the statistical. This enables an alternative formulation of quantum mechanics with which is associated that classical model. Such a formulation leads, however, if developed straightforwardly according to the model, to a theoretical scheme quite different from that of ordinary quantum mechanics concerning problems other than the equation of motion. Furthermore, this formulation is not applicable to fermions when spin, or exclusion principle is taken into account. Bohm's recent revised form of the statistical interpretation of quantum mechanics referring to this formulation is criticized in several points. On this formulation a singular ensemble can be constructed which is shown to correspond to the transformation kernel of the wave function at an infinitesimally later instant, and thus a connection between this formulation and that of Feynman's is obtained. A hydrodynamical model formally equivalent to the statistical model in one-body problems is also considered, and from this analogy a formal generalization of the Schrödinger equation is suggested. A.

530.162

8243. A statistical theory of linear dissipative systems. N. HASHITSUME. *Progr. theor. Phys.*, **8**, 461–78 (*Oct.*, 1952).

On the basis of the joint probability for two states occurring at different times proposed by Onsager, the theory of Brownian motion is generalized to the case of isolated systems such as treated by "the thermodynamics of irreversible processes." Fokker–Planck's and Langevin's equations are also generalized. When the deviations from thermal equilibrium are so small that the entropy of the system is expressible in a quadratic form with respect to its state variables, these equations are integrated, and the probability distribution for the state variables at each time is obtained. As two examples, the problems of the Brownian motion of a free colloidal particle in a uniform isotropic medium and of the heat conduction along an isolated one-dimensional rod are treated. The result of the former coincides with the usual one, but that of the latter differs essentially from the Orstein–Milatz theory (1939). A.

530.162

8244. The pair distribution function for a one-dimensional gas. R. L. SELLS, C. W. HARRIS AND E. GUTH. Letter in *J. chem. Phys.*, **21**, 1422–3 (*Aug.*, 1953).

It is pointed out that, in the one-dimensional case, the triplet distribution function can be expressed exactly in terms of the doublet distribution functions, and this fact is used to solve the one-dimensional Born–Green equation rigorously for the square-well model. E. H. SONDHEIMER

GENERAL MECHANICS MECHANICS OF SOLIDS 531

531.553

8245. A mechanical hodoscope. C. MILONE. Note in *Nuovo Cimento*, **10**, 340–2 (*March*, 1953) *In Italian.*

Describes a simple recording instrument which has given satisfactory results. A.

MECHANICAL MEASUREMENTS 531.7

531.711.1 : 778.3

8246. The possibility of comparing line standards of length photographically. A. H. COOK. *Proc. Roy. Soc. A*, **219**, 500–15 (*Oct.* 7, 1953).

Line standards can be compared visually to about one in ten millions. It seems possible that in a photographic comparison appreciably higher precision could be attained with less labour. Photographs of the lines on some line standards have been examined with a densitometer to determine the accuracy with which the distance between two photographic images of such lines could be measured. With suitable definition of line position a single measurement of this distance should have a standard deviation corresponding to less than $0{\cdot}05\,\mu$. Provided the temperature of the bars is known with sufficient accuracy it should be possible to compare two line standards to much better than one in ten millions in less than half the time taken by present visual methods. A machine for measuring the photographs is suggested. The characteristics of photographs of some lines are given in an appendix. A.

531.724

8247. A method for the determination of the approximate surface areas of particulate solids. D. PAYNE. Letter in *Nature* [*London*] **172**, 261 (*Aug.* 8, 1953).

A simple apparatus (consisting of a burette and Buchner funnel) for the determination of moisture content as a function of suction pressure, and its application to the determination of surface areas of glass spheres in the range 18 to 150 cm^2 per gram, is described. S. J. GREGG

531.73 : 621.317.39

8248. A simple electrical method of recording small volume changes. J. G. DAVIES. *J. sci. Instrum.*, **30**, 306–9 (*Sept.*, 1953).

The recording pen of a float volume recorder is replaced by an opaque flag which moves in a vertical plane between a light source and a photoelectric cell, Volume increases cause the flag to rise and allow more light to fall on the photoelectric cell, the resulting electrical changes being recorded. Sensitivity may be varied by modifying the light intensity, by altering the photoelectric cell load resistance or by employing a float recorder of different capacity. Using a galvanometer with a resistance of 2000 Ω and a float recorder of 80 ml capacity, 1 mA/ml is the maximum sensitivity. Initial calibration of the instrument determines the range over which output remains linear for given

volume increments. Calibration after each series of observations is made by introducing known amounts of air into the float. The instrument has proved satisfactory for recording volume changes of the limbs in venous occlusion plethysmography and in registering respiratory changes. A.

531.752

8249. Differential thermobalance: a new research tool. W. L. De Keyser. Letter in *Nature* [*London*] **172,** 364–5 (*Aug.* 22, 1953).

The advantages of obtaining photographic records of the differential $dp/dt = f'(t)$ instead of the curve $p = f(t)$ representing the loss of weight of a sample during heating are explained and illustrated with reference to the dehydration of diaspore. The automatic apparatus, briefly described, consists of two tubular electric ovens, the temperature of one being 4°c above the other; a balance, on the trays of which are hung crucibles which are within the ovens and which contain exactly equal quantities of the substance to be analysed; and a recording drum. The movement of the beam of the balance is detected by means of a mirror attached to the beam and suitable optical system not described. S. WEINTROUB

531.761 : 534.88

8250. Measurement of short time intervals, with particular application to distance measurement by sound echo methods. H. H. Rust. *Z. angew Phys.*, **5,** *No.* 6, 237–40 (1953) *In German.*

The paper deals with various arrangements for indicating and recording time intervals of the order of 1 millisec. Echo depth sounding arrangements are described under the headings: optical indicators; recorders. It is pointed out that such time indicators and recorders might have a much wider application than in echo depth sounding. A. B. WOOD

531.787

8251. An inexpensive recording differential manometer suitable for reaction kinetics measurements. G. R. Thomas and N. N. Lichtin. *Rev. sci. Instrum.*, **24,** 661–4 (*Aug.*, 1953).

A differential manometer which photographically records pressure as a function of time is described. A fluorescent lamp in conjunction with a simple louvre system provides a sharp image of the interface between indicator liquid and gas. The instrument can be used to study reactions whose half-lives range from a few seconds to several hours. A.

531.787

8252. A simple micromanometer. E. Kovačič. *J. sci. Instrum.*, **30,** 304–5 (*Sept.*, 1953).

The components are two glass vessels or U-tubes and a short capillary tube, wherein the displacement of a small air-bubble indicates the difference of pressures applied. With one liquid, the instrument can be used for measuring steady differential air pressures, and for differential water pressure measurements a sealing liquid, immiscible with water, is necessary. Because high magnification is possible, pressure differences down to 0·01 mm can be measured. Some construction details and remarks on accuracy and sensitivity are also given. A.

MECHANICS OF FLUIDS 532

532.137

8253. On the oscillating cylinder viscometer. A. A. K. Ibrahim and A. M. Kabiel. Letter in *Nuovo Cimento*, **10,** 87–8 (*Jan.*, 1953).

A simple absolute formula for the viscosity, applicable to Newtonian liquids with $\eta > 1$. R. O. DAVIES

532.511

8254. A method of observation and measurement of water currents by means of tellurium. F. X. Wortmann. *Z. angew. Phys.*, **5,** *No.* 6, 201–6 (1953) *In German.*

A Te wire is immersed in the water. Colloidal Te particles are formed by an electrical impulse lasting a few milliseconds. The position of the boundary of the colloidal cloud at a later time allows the flow velocity to be found. Practical details of the apparatus are given and photographs of typical flow patterns shown. 6 refs. R. W. FISH

532.59

8255. Contribution to the study of surface and interfacial waves. R. Mercier. *Helv. phys. Acta.*, **26,** *No.* 3–4, 317–28 (1953) *In French.*

The velocity potential for cylindrical waves on the surface of a liquid of infinite depth and zero viscosity is derived in terms of Hankel functions. Expressions for the velocity and phase of the waves are obtained and an experimental method for determining the phase at different distances from the source, and hence the surface tension, is briefly described. Similar results for waves at the surface of separation of two immiscible liquids of different density are given. J. E. CAFFYN

532.59

8256. The eigenvalues of $\nabla^2 u + \lambda u = 0$ when the boundary conditions are given on semi-infinite domains. D. S. Jones. *Proc. Cambridge Phil. Soc.*, **49,** *Pt* 4, 668–84 (1953).

The spectrum of $-\nabla^2$ (and of $-\nabla^2 + b$) is investigated when the boundary conditions are given on surfaces which extend to infinity. Simple criteria are obtained for determining whether point-eigenvalues are present in the lower part of the spectrum. Semi-infinite domains which are conical at infinity are found to possess purely continuous spectra when the boundary condition is $u = 0$ or $\partial u/\partial \nu = 0$; the radiation condition ensures a unique solution. A counter-example shows that this is not true in general for the boundary condition $\partial u/\partial \nu + \sigma u = 0$. Semi-infinite domains which are cylindrical at infinity have a continuous spectrum with a discrete spectrum embedded in it. An example is given. The results are applied to the theory of surface waves. It is shown that Ursell's "trapping modes" can occur in a canal of finite width when the bed has a protrusion over a finite length but is otherwise of uniform depth. Trapping modes can also occur when the canal contains a submerged cylinder (not necessarily small in cross-section). A.

532.59

8257. The long-wave paradox in the theory of gravity waves. F. URSELL. *Proc. Cambridge Phil. Soc.*, **49**, *Pt* 4, 685–94 (1953).

It was shown by Airy (1845) that, if the pressure at any point in the fluid is equal to the hydrostatic head due to the column of water above it, then no wave form can be propagated without change in shallow water of uniform depth; on the other hand, it was shown by Rayleigh's theory (1876) of the solitary wave that this conclusion may be incorrect. In the present paper an attempt is made to elucidate the paradox. Waves of small amplitude η_0 and large horizontal wavelength λ (compared with the depth h of the water) are studied, and it is shown that Airy's conclusion is valid if $\eta_0\lambda^2/h^3$ is large, whereas the solitary wave has $\eta_0\lambda^2/h^3$ of order unity. Equations of motion are derived corresponding to large, moderate and small values of $\eta_0\lambda^2/h^3$. It is also shown that the linearized theory of surface waves is valid only if η_0/λ and $\eta_0\lambda^2/h^3$ are both small. Some remarks are made on the generation of the solitary wave, and on the breaking of waves on a shelving beach. A.

532.59 : 531.717.31 : 621.317.79

8258. A wave-height analyser. M. J. WILKIE AND R. F. KING. *J. sci. Instrum.*, **30**, 311–14 (*Sept.*, 1953).

In experimental work on models of harbours and beaches successive waves are, as in nature, of different amplitudes. The wave height analyser measures and records the height of each of a train of 300 waves. From the results the "significant wave height" and the height distribution can be determined. Thirty-two Post Office telephone call meters are provided, each corresponding to a particular wave height. Each wave produces a group of voltage pulses, the number being proportional to wave height. These operate a counter which selects the appropriate P.O. meter, a count of one being recorded on this meter as the water level falls. The instrument records wave height from trough to following crest, and is not affected by slow changes of mean water level. A.

532.591

8259. On the decrease of velocity with depth in an irrotational water wave. M. S. LONGUET-HIGGINS. *Proc. Cambridge Phil. Soc.*, **49**, *Pt* 3, 552–60 (1953).

The following theorems are proved for irrotational surface waves of finite amplitude in a uniform, incompressible fluid: (*a*) In any space-periodic motion (progressive or otherwise) in uniform depth, the mean square of the velocity is a decreasing function of the mean depth z below the surface. Hence the fluctuations in the mean pressure $\bar{p}$ increase with z. (*b*) In any space-periodic motion in infinite depth, the particle motion tends to zero exponentially as z tends to infinity. The pressure fluctuations at great depths are therefore simultaneous, but they do not in general tend to zero. (*c*) In a progressive periodic wave in uniform depth the mass-transport velocity is a decreasing function of the mean depth of a particle below the free surface, and the tangent to the velocity profile is vertical at the bottom. This result conflicts with observations in wave tanks, and shows that the waves cannot be wholly irrotational. (*d*) Analogous results are proved for the solitary wave. A.

CAPILLARITY 532.6

532.612.4

8260. The surface tension of liquid iron–carbon alloys. P. KOZAKEVITCH, S. CHATEL AND M. SAGE. *C.R. Acad. Sci.* [*Paris*] **236**, 2064–6 (*May* 27, 1953) *In French.*

This was obtained from measurements of the shape and size of drops of the molten alloys (C content 0·1 to 5%), supported on a concave surface, as revealed by the shadow they cast in an X-ray beam. $\gamma = 1600 - (100 \times \%C)$ dynes/cm. Taken with other measurements of the tension of slag–alloy surfaces, the present results show that the degree of wetting at a slag–alloy interface is independent of the C content of the alloy. A. D. LE CLAIRE

532.62

8261. Observations of some phenomena of surface expansion in the Devaux mercury trough. R. PÉRALDI. *J. Phys. Radium*, **14**, 20S–21S (*May*, 1953) *In French.*

The following new experimental values have been obtained by the author for the area σ_0 "occupied" by a single molecule in a unimolecular layer (Devaux' pulsation method): stearic acid, 18·9 Å^2, castor oil, 60·6 Å^2 (the calculated values being 20·5 and 63 Å^2, respectively). The pulsation method, giving a smaller value for the area of the unimolecular layer, seems to be more accurate than the "camphor immobilization" method. Observation of the expansion of solids with polar molecules (stearic acid, salol, orthochloronitrobenzene) reveals certain peculiarities that have so far remained without explanation, but seem to point to a phenomenon similar to sublimation. F. LACHMAN

532.63

8262. Electrostatic atomization of liquids. H. STRAUBEL. *Naturwissenschaften*, **40**, *No.* 12, 337 (1953) *In German.*

A brief note describing experiments in which a liquid which would otherwise just not emerge from a small nozzle forms a fine spray on the application of a potential of 10–20 kV. M. R. HOPKINS

MOLECULAR THEORY OF LIQUIDS 532.7

532.7

8263. On some new recurrence relations between molecular distribution functions. A. LION. *Physica*, **19**, 627–35 (*July*, 1953) *In French.*

It is shown that it is possible to generalize a method used by Price [Abstr. 2468 (1952)] in his calculation of classical compressibility, in order to obtain some new recurrence relations between the partial distribution functions of consecutive orders, and their derivatives with respect to density or temperature. Both of these new sets of relations include a term which is given by an integral having the same structure as the fluctuation-in-density integral. A.

532.7

8264. A contribution to the theory of dipole liquids. II. Experimental investigations. A. LÖSCHE. *Z. phys. Chem.*, **202**, 95–107 (*July*, 1953) *In German.*

In the model of a dipole liquid, developed in Pt I

[Abstr. 5893 (1953)], the composition of the individual microscopically-small crystalline regions (aggregates) varies continuously. The relaxation period of a single molecule must be shorter than the period of its migration from one sphere of influence to another. When the temperature-dependent effective radius $(r_w = (|\mathfrak{m}|^2/kT)^{1/3}$, where $\mathfrak{m}$ is the dipole moment of a single molecule) of the individual aggregates becomes smaller than the smallest possible distance between dipoles r_{min}, the dielectric behaviour changes from that of a dipole liquid to that of a dipole gas. The temperature of transformation is $T_s = |\mathfrak{m}|^2/kr^3_{min}$, where $r_{min} \simeq$ the average diameter of a single molecule. Results of measurements (refractive index, density, dielectric constant) on $C_6H_5NO_2$, H_2O and C_2H_5OH show that the dielectric behaviour of dipole liquids can be described by assuming the existence of oriented aggregates whose radius thus becomes a new characteristic magnitude. F. LACHMAN

532.7 : 537.531

8265. Diffraction of X-rays in liquids. F. CENNAMO. *Nuovo Cimento*, **10**, 395–404 (*April*, 1953) *In Italian.*

Describes the experimental method employed in determining the intensity of X-rays diffracted by liquids, and results are given for benzene and cyclohexanol. A.

532.72

8266. Diffusion accompanied by absorption of the Langmuir type. H. FUJITA. Note in *J. Phys. Soc. Japan*, **8**, 271–2 (*March–April*, 1953).

With reference to other work published later, it is shown how for polymer-solvent systems diffusion with absorption of the Langmuir type can be represented as a case of simple diffusion. T. C. TOYE

532.72 : 534.321.9

8267. Effect of ultrasonics on the processes of migration of particles in liquids. K. ALTENBURG. Note in *Naturwissenschaften*, **40**, *No.* 10, 289 (1953) *In German.*

A brief survey of experimental work on the effect of ultrasonics on diffusion and ionic mobility (conductivity) is followed by an attempt at evaluating the magnitude of the effect, based on the theory of the migration of particles in liquids. F. LACHMAN

532.73

8268. Limiting laws for an infinite dilution as a result of a universal theorem of concentrated mixtures. R. HAASE. *Z. Naturforsch.*, **8a**, 380–93 (*June*, 1953) *In German.*

It is shown that these limiting laws can be derived from the following theorem: the logarithms of the coefficients of activity of all kinds of particles, when regarded as functions of the independent concentrations, can be represented as power series in these variables with non-negative exponents. The theorem, merely a generalization of some results of statistical mechanics, agrees with experimental data. The following problems are discussed in more detail for the binary systems: limiting laws for partial pressures in solutions (both of electrolytes and non-electrolytes), and the limiting gradient of the melting-point curve when both the solvent and the solute undergo dissociation. F. LACHMAN

533.15

8269. Experiments on the deposition of iodine 131 vapour onto surfaces from an airstream. A. C. CHAMBERLAIN. *Phil. Mag.*, **44**, 1145–53 (*Oct.*, 1953).

Experiments are described on the deposition of "carrier-free" I^{131} vapour from a moving airstream on to surfaces. With copper and filter paper surfaces and at low or moderate Reynolds numbers, the deposition is controlled by aerodynamical factors, and the analogy with heat transfer by forced convection holds. The detailed deposition pattern produced by an obstacle on a flat plate is shown by a radioautograph. A.

533.15 : 534.22

8270. Measurements on thermal diffusion with the use of ultrasonics. A. VAN ITTERBEEK, G. FORREZ AND P. MARIENS. *Physica*, **19**, 525–34 (*June*, 1953).

Thermal diffusion of H_2–N_2 mixtures is measured for $T_1 = 291°K$ and $T_2 = 90°K$. The concentration of the mixture, and its change with time is deduced from the velocity of sound, measured in the low temperature part of the apparatus by means of an acoustical interferometer (frequency 500 kc/s). In this way, the total change of the concentration is determined as a function of the concentration. The accuracy of the measurements is discussed and compared with the earlier ones. [Abstr. 1654 (1951)]. A.

533.15 : 541.183

8271. Anomalous diffusion of acetone into cellulose acetate. F. A. LONG, E. BAGLEY AND J. WILKENS. Letter in *J. chem. Phys.*, **21**, 1412–13 (*Aug.*, 1953).

Describes sorption experiments with acetone and cellulose acetate (37·9% acetyl) for a series of successively higher, narrow pressure ranges of acetone. Contrary to previous findings by other authors, it was found that the major anomaly in sorption occurs very early in the sorption process. F. LACHMAN

533.16

8272. The viscosity of heavy water vapour. J. S. ROWLINSON. Letter in *Physica*, **19**, 303–4 (*March*, 1953).

Measurements of the ratio of viscosities of D_2O and H_2O vapours show that the anomalous ratio found for D_2O and H_2O liquid does not persist for the vapours. It is concluded that the motions of the D_2O and H_2O molecules in the intermolecular force fields of the liquids are not the same. R. H. DAVIES

533.16

8273. Measurements on the viscosity of mixtures of helium and argon. A. O. RIETVELD, A. VAN ITTERBEEK AND G. J. VAN DEN BERG. *Physica*, **19**, 517–24 (*June*, 1953).

The coefficient of viscosity of a mixture of helium and argon was determined by the method of the oscillating disk at 291·1°, 230°, 193°, 90°, 81° and 72°K. The maximum in the "viscosity coefficient/concentration of helium" curve appears to shift to higher He concentrations at decreasing temperatures. The curve calculated with the help of the formula and tables of Hirschfelder, Bird and Spotz (Lennard-Jones 12–6 model) does not quite agree with the experimental curve, but gives less deviations than that calculated by Wilke and Bock. A.

533.5

8274. New developments in the production and measurement of ultra high vacuum. D. ALPERT. *J. appl. Phys.*, **24,** 860–76 (*July*, 1953).

A new vacuum technology is described which makes it possible to achieve working pressures as low as 10^{-10} mm Hg in a routine and straightforward fashion, without the use of chemical getters, special traps, or refrigerants of any kind. Essential to this technology are several new instruments including an improved ionization gauge [Abstr. 7792 (1950)] with fine wire anode; and vacuum valves of all-metal construction capable of being baked, and with conductances when closed of 10^{-11} l/sec or less. The highest vacua are obtained by utilizing the pumping action of the ionization gauge. Various aspects of the technique for attaining and manipulating these high vacua are discussed, and items of auxiliary equipment described.

533.5

8275. Measurement of force required to pull through a 1 in. diameter Wilson vacuum seal. D. MCLEAN AND M. H. FARMER. Note in *J. sci. Instrum.*, **30,** 293 (*Aug.*, 1953).

The construction of a Wilson vacuum seal, as an alternative to the mercury seal, is described and its frictional resistance to pulling determined. For an adequately greased seal this was found to be about ½ kg, which could be ignored in tensile creep tests in vacuum (loads 100 to 500 kg) on copper and other materials liable to Hg contamination. G. WITTENBERG

533.5 : 533.6.08

8276. A vacuum anemometer. D. J. TREVOY AND W. A. TORPEY. *Rev. sci. Instrum.*, **24,** 676–82 (*Aug.*, 1953).

The device is particularly useful for measuring the projective vapour emission from liquid surfaces and the flow of gas through pipes, for instance, between a vessel and a pump. It consists of a propeller mounted on a shaft supported by jewelled bearings, the propeller being driven by the stream of gas. To measure the speed of the propeller, a small a.c. generator is incorporated in the device, and the output is indicated by an electronic voltmeter. Under conditions of heavy electrical braking, it is shown that the speed is directly proportional to the pressure, independent of the nature of the gas and of its molecular weight. The instrument is robust, insensitive to vibration, stable and readily calibrated. It has low inertia and responds rapidly to a change in the momentum of the stream of incident molecules. Sources of error are discussed and typical performance data are reported. D. A.

MOLECULAR THEORY OF GASES 533.7

533.75

8277. The law of corresponding states. D. TER HAAR. Letter in *Physica*, **19,** 375–6 (*April*, 1953).

It is shown that Buckingham's values [*Proc. Roy. Soc. A*, **168,** 264–83 (*Oct.* 25, 1938)] of the intermolecular potential energy constants for He, Ne and A satisfy de Boer's condition [Abstr. 795 (1950)] for the existence of a law of corresponding states.

R. H. DAVIES

VIBRATIONS . ACOUSTICS 534

534.113

8278. Longitudinal elastic waves in cylindrical rods. R. E. D. BISHOP. Letter in *Nature* [*London*] **172,** 169 (*July* 25, 1953).

The predicted higher modes in Pochhammer's analysis of longitudinal waves have not been observed in cylindrical rods, and an explanation of their physical significance is still required. The usual solution for reflexion at a free end is not quite exact, and the question arises whether the error can be regarded as a local one, by a dynamical analogue of St. Venant's principle. J. G. OLDROYD

534.121.1 : 621.896.611.21

8279. The piezo-electric oscillations of a quartz crystal at its odd, even and half-odd harmonics. S. PARTHASARATHY, M. PANCHOLY AND A. F. CHHAPGAR. *Ann. Phys.* [*Leipzig*] **12,** *No.* 1–3, 1–7 (1953).

Measurements are described of the intensity of diffraction patterns which show that a piezoelectric crystal can be set into forced vibrations at any frequency imposed upon it but there are preferred frequencies at which the amplitude of oscillation is greater. At frequencies in the region of the 25th harmonic, the preferred frequencies are the odd harmonics (max. amplitude) and the even and half-odd harmonics. These observations confirm the authors' earlier conclusions [Abstr. 2440 (1953)], which have been criticized. H. J. H. STARKS

534.141.3

8280. On the oscillations of a bowed string. F. G. FRIEDLANDER. *Proc. Cambridge Phil. Soc.*, **49,** *Pt* 3, 516–30 (1953).

The small transverse oscillations of a string excited by bowing are treated by neglecting all external forces except that due to the bow, taking the ends of the string as fixed, and replacing the bow by a concentrated force acting transversely at the "bowing point," whose magnitude depends on the velocity, v, of the string at this point. Non-linear recurrence equations for v are obtained, from which some of the principal features of the motion can be inferred, and some qualitative conditions about the dependence of the transverse force of the bow on v can be drawn. A detailed examination of the case when the string is bowed at the mid-point shows that, in order to account for the stability of the periodic motion excited, it appears to be necessary to allow for the effect of dissipative forces, such as air friction; to a first approximation this can be done by postulating a small concentrated dissipative force at the bowing point in addition to the frictional force exerted by the bow. The theory predicts that for small bowing speeds a "noise" is produced instead of a note; this phenomenon does not appear to have been noted in the literature, but can easily be verified in practice. A.

534.154

8281. A method of examining the transverse vibrations of rods and reeds. P. L. KIRBY. *Brit. J. appl. Phys.*, **4**, 279–80 (*Sept.*, 1953).

Apparatus is described with which the vibrations of a thin rod or reed are transformed by means of a capacitance-type electromechanical transducer and a capacity-sensitive circuit into varying electrical potentials. The latter are displayed on a voltmeter and oscillograph, and techniques are described for measuring the internal friction or damping capacity at frequencies of vibration from ten to several hundred cycles per second. A.

534.22

8282. On the homogenization of ultrasonic fields in water. A. ECKARDT, O. LINDIG AND K. NITZSCHE. *Ann. Phys.* [*Leipzig*] **12**, *No.* 4–6, 237–9 (1953) *In German.*

A study of the influence of an alcohol/water mixture on the dispersion of ultrasound. T. C. TOYE

534.22

8283. Dispersion of ultrasonic velocity in some organic liquids. S. PARTHASARATHY, A. F. CHHAPGAR AND H. SINGH. *Nuovo Cimento*, **10**, 260–3 (*March*, 1953).

By exciting two crystals simultaneously at two different frequencies of about 4 and 16 Mc/s in the same medium and photographing the superposed diffraction pattern, the velocities of ultrasonic waves in some organic liquids, particularly esters, were measured. The results show no dispersion of velocity within the experimental error of 1 metre in a thousand. A.

534.22

8284. Absorption of ultrasonic waves in liquids at 5 MHz from thermal considerations. S. PARTHASARATHY, D. SRINIVASAN AND S. S. CHARI. *Nuovo Cimento*, **10**, 264–7 (*March*, 1953).

The absorption coefficients of several organic liquids were determined from thermal measurements alone, at 5 Mc/s, making use of the fact that the heat output due to the passage of ultrasonics in liquids bears a constant ratio to the absorption coefficient of ultrasonics, provided the same voltage is applied to the crystal. A.

534.22

8285. Measurement of velocity of elastic waves in solids at elevated temperatures. P. G. BORDONI AND M. NUOVO. *Nuovo Cimento*, **10**, 386–94 (*April*, 1953) *In Italian.*

The velocity c of extensional waves has been determined as a function of temperature T for five pure metals (Pb, Sn, Bi, Al and Cd). The vibration frequency had its lowest value for cadmium (9000 c/s at 20°c) and the highest one for aluminium (25 483 c/s at 20°c); the strain was of the order of 10^{-8}. From the experimental data the coefficient $\beta = -\partial \log c/\partial T$ has been computed, and the curves $\beta(T/T_c)$ traced T_c being the melting point temperature. Inspection of the above curves, and their comparison with the corresponding ones for the thermal expansion coefficient $\alpha_c = \partial \log V/\partial T$ suggest the following conclusions: (1) For the five metals investigated the $\beta(T/T_c)$ curves look substantially alike, notwithstanding some relaxation phenomena, which occur in the aluminium and cadmium samples. (2) All these curves in an intermediate temperature range are straight lines and in the same range β keep almost constant. (3) For every metal among the five considered, and for $T < 0{\cdot}7\,T_c$ the β and α_c-curves are rather similar to one another. (4) When T gets near the melting point value the β-curve becomes more and more steep, while nothing of the kind happens in the α_c-curve.

534.2

8286. Velocity of ultrasound in methane at pressures up to 950 atm. A. LACAM. Letter in *J. Phys. Radium*, **14**, 426–7 (*June*, 1953) *In French.*

Measurements have been made using a light diffraction method. The velocity increases fairly uniformly with pressure between 100–950 atm and also with increasing temperature up to a pressure of 220 atm; above this pressure, however, increase of temperature causes a lowering of velocity. T. C. TOYE

534.21

8287. The velocity of sound in high polymers. K. ALTENBURG. *Z. phys. Chem.*, **202**, 14–34 (*July*, 1953) *In German.*

The author's previous work in a number of references has assumed the molecule to be a mass point. The velocity of sound in high polymer liquids is calculated assuming the existence of two types of forces, the van der Waals forces between foundation molecules of different macromolecules and the valence forces within the macromolecules. The equations obtained are very similar to those for the calculation of sound velocity in liquid mixtures. T. C. TOYE

534.22

8288. Velocity of sound in air at low pressures. D. E. CARO AND L. H. MARTIN. *Nature* [*London*] **172**, 363–4 (*Aug.* 22, 1953).

Because of the meteorological significance and the implication in supersonic aerodynamics, the authors have carried out a new determination of the velocity of sound in air at pressures down to 5 mm Hg. The method used was to measure the transit time of a pulsed sine wave between two condenser microphones situated 4 m apart in a long tube. After applying the various tube corrections to the measured velocities the authors conclude that down to pressures of 5 mm Hg there is no variation with pressure of the free-space velocity for the frequencies studied (250 and 1000 c/s). A. B. WOOD

534.22 : 539.132

8289. Ultrasonic dispersion in halo-methane vapours. P. G. T. FOGG, P. A. HANKS AND J. D. LAMBERT. *Proc. Roy. Soc. A*, **219**, 490–9 (*Oct.* 7, 1953).

The velocity of ultrasonic waves has been measured in the vapours of methyl fluoride, chloride, bromide and iodide, methylene fluoride and chloride, fluoroform and chloroform, carbon tetrafluoride and carbon tetrachloride, at frequencies 200, 566, 1192 and 4000 kc/s, pressures ranging from 0·25 to 2 atm, and temperature 100°c. Dispersion, or incipient dispersion, occurs in all cases. Each dispersion zone observed corresponds to a single relaxation time, involving disappearance of the whole of the molecular vibrational energy. On the assumption that vibra-

tional energy is taken up via the mode of lowest frequency, a simple functional relation is found to exist between the frequency of this mode and the probability of vibrational energy being acquired in collision. The theoretical significance of this is discussed. The paper includes second virial coefficient data for all the vapours investigated. A.

534.222.2 : 538.561

Magneto-hydrodynamic shock waves in a plasma of infinite conductivity. *See Abstr.* 8583

534.23 : 535.417

8290. Ultrasonic interferometry in gases. IV. Absorption of ultrasonics in ammonia. S. Petralia. *Nuovo Cimento*, **10**, 817–26 (*June*, 1953) *In Italian.*

For Pt III, see Abstr. 7527 (1953). The absorption coefficient and the velocity of ultrasonics in ammonia at 20°c and pressures variable between 3 and 60 cm Hg have been measured at the frequency 2·993 Mc/s of the ultrasonics source. The absorption result is greater than the one classically foreseen; the ratio m_{sp}/mol_{cl} is 1·81 for f/p variable between 4 and 50 Mc/s and shows a tendency to diminution for greater values of f/p. Also increasing velocity was observed with increasing f/p. Those facts are interpreted as a consequence of the slowness of energy exchanges between translation and rotation states. The corresponding relaxation time is $8{\cdot}1\times10^{-10}$ sec and, therefore, the middle region of the dispersion curve is situated at about 393 Mc/s. The number of collisions necessary for an exchange of energy is 10. The contribution to the volume viscosity of the gas due to rotational relaxation is further computed. The measurements were taken with an interferometric device which is described. A.

534.23

8291. Thermal investigation on the absorption of ultrasonics in liquids. S. Parthasarathy, D. Srinivasan and S. S. Chari. *Z. Phys.*, **135**, *No.* 4, 395–402 (1953) *In German.*

Measurements of heat produced in a large number of liquids by the passage of ultrasonic waves at frequencies near to 420 kc/s show strong proportionality between the quantity of heat produced and the classical value of the absorption coefficient. It is concluded that at these frequencies, therefore, the classical assumptions concerning the absorption of liquids are correct. T. C. TOYE

534.23

8292. The relation of the temperature effects of ultrasonics in liquids to their absorption coefficients. S. Parthasarathy, D. Srinivasan and S. S. Chari. *Z. Phys.*, **135**, *No.* 4, 403–5 (1953) *In German.*

The proportionality between the quantity of heat produced and the absorption coefficient found by the authors at 420 kc/s (preceding abstract) does not occur at 5 and 15 Mc/s. T. C. TOYE

534.23

8293. Viscosity as a factor in the anomalous absorption of ultrasonic waves in liquids. S. Parthasarathy and A. F. Chhapgar. *Ann. Phys.* [*Leipzig*] **12**, *No.* 4–6, 316–20 (1953).

The Q of a crystal (considered as an equivalent electrical circuit) immersed in various liquids is measured by recording the current due to the damped vibrations of the crystal on a c.r.o. For anomalously absorbing liquids, for which a high second viscosity is often assumed, Q should be very low. In a very comprehensive series of experiments it is shown that this does not occur; it would appear that the existence of the postulated second viscosity is extremely doubtful. T. C. TOYE

534.23 : 538.65

Ultrasonic attenuation in magnetic single crystals. *See Abstr.* 8602

534.25

8294. Bending of acoustic waves at a small circular opening. T. Anders. *Z. Phys.*, **135**, *No.* 2, 219–24 (1953) *In German.*

A mathematical paper dealing with refraction theory and involving the solution of two simultaneous integral equations. Reference is made to previous work by H. Hönl [Abstr. 5702 (1952)]. A. B. WOOD

534.26

8295. On the energy scattered from the interaction of turbulence with sound or shock waves. M. J. Lighthill. *Proc. Cambridge Phil. Soc.*, **49**, *Pt* 3, 531–51 (1953).

The energy scattered when a sound wave passes through turbulent fluid flow is studied by means of the author's general theory of sound generated aerodynamically. The energy scattered per unit time from unit volume of turbulence is estimated as $(8\pi^2L_1/\Lambda^2)\,.\,I\,.\,(\overline{v_1'^2}/a^2)$, where I is the intensity and Λ the wavelength of the incident sound, and $\overline{v_1'^2}$ is the mean square velocity and L_1 the macro-scale of the turbulence in the direction of the incident sound. This formula does not assume any particular kind of turbulence, but does assume that Λ/L_1 is less than about 1. For turbulence which is isotropic and homogeneous, the energy scattered, and its directional distribution, are obtained for arbitrary values of Λ/L_1. It is predicted that components of the turbulence with wave-number k will scatter sound of wave-number κ at an angle $2\sin^{-1}(k/2\kappa)$. The statistics of multiple successive scatterings is considered, and it is predicted that sound of wavelength less than the micro-scale λ of the turbulence will become uniform (i.e. quite random) in its directional distribution in a distance approximately $\lambda a^2/\overline{v_1'^2}$. The theory is extended to the case of an incident acoustic pulse. However, this extended theory cannot be applied directly to the case of a shock wave, for which it would predict infinite scattered energy. This is due to the perfect resonance between successive rays emitted forwards which would occur if the shock wave were propagated at the speed of sound. By taking into account the true speed of the shock wave (subsonic relative to the fluid behind it), the theory is improved to give a finite value, $0{\cdot}8s$ times the kinetic energy of the turbulence traversed by a weak shock of strength s, for the total energy scattered. However, the greater part of this energy catches up with the shock wave, and probably is mostly reabsorbed by it, and only the remainder is freely scattered, behind the shock wave, as sound. The energy thus freely scattered when turbulence is convected through the stationary shock-wave pattern in a supersonic jet may form an important part of the sound field of the jet. A.

534.26

8296. Infinite matrices associated with diffraction by an aperture. W. MAGNUS. *Quart. appl. Math.*, **11**, 77–86 (*April*, 1953).

The matrices arise in a boundary value problem concerning the diffraction of a plane (acoustical) wave by a plane screen with a circular aperture. They were introduced in a previous paper [Abstr. 4694 (1949)], in order to obtain an expression for the diffracted field u. It is now shown that various algebraic properties of the matrices (e.g. a suitable factorization) enables one to determine u more accurately.

L. S. GODDARD

534.3

8297. On the relation between electrical and mechanical sound production. R. BIERL. *Z. angew. Phys.*, **5**, *No.* 6, 231–7 (1953) *In German.*

The paper deals with a comparison of the characteristics of mechanical and electrical musical instruments. Discusses the overtones and frequency spectra of the clarionet, the oboe and the horn, and the principal ranges of electronic musical instruments. A table is given comparing the more important characteristics of mechanical and electrical sound producers. In the latter are considered human speech, mechanical musical instruments, electrosynthetic music and synthetic speech. The author describes what he calls a "Klangfarben–Intervall–Zirkel," as a means of classifying musical instruments. A. B. WOOD

534.321.9

8298. Ultrasonic microscope. G. B. DEVEY. *Radio-Electronic Engng*, **1953**, 8–9 (*Feb.*). [Translated from the Russian of S. Y. Sokolov in *Uspekhi Fizicheskikh Nauk*, *Vol.* 40 (*Jan.*, 1950)].

The production of ultrasonic waves having a wavelength of the order of visible light, coupled with the fact that most materials are transparent to ultrasonic waves, makes it possible to obtain magnified images of opaque objects. Several versions of the ultrasonic microscope are described. In principle, the object is illuminated with a continuous or pulsed ultrasonic beam and the reflected waves fall on an acoustical collector lens which brings them to a focus on a quartz plate forming part of an electron tube. In this tube, the quartz plate is subjected to electron bombardment and by a process of secondary electron emission gives rise, after amplification, to an image on the screen of a subsidiary cathode-ray tube. Alternatively, the inner surface of the quartz plate may be coated with a photosensitive layer; this is irradiated with a u.v. beam and the photo-electrons emitted are imaged on a fluorescent screen. A third method produces an image by a scanning process. In water, the wavelength of ultrasonic waves at a frequency of 3000 Mc/s is 5×10^{-5} cm and at that frequency the resolving limit of the ultrasonic microscope may reach that of the optical microscope. Several low-magnification pictures are reproduced, one showing metallic wires immersed in an opaque liquid. H. J. H. STARKS

534.321.9 : 532.72

Effect of ultrasonics on the processes of migration of particles in liquids. *See Abstr.* 8267

534.3

8299. The internal damping of an initially stresse medium. E. SCHREUER. *Z. Naturforsch.*, **8a**, 322- (*May*, 1953) *In German.*

The dependence of the internal damping c frequency and amplitude is derived assuming th existence of an initial stress and a single relaxatic time. J. E. CAFFY

534.8

8300. Practical application of the under-water spar as a source for echo sounding. H. H. RUST AN H. DRUBBA. *Z. angew. Phys.*, **5**, *No.* 7, 251–2 (1953 *In German.*

The chief advantage of the underwater spark is tha it gives a pressure impulse of high intensity and sho duration. The equipment developed by the Germa Hydrographic Institute is described and illustrate with an echo record from the sea bed (fine sand an mud; reflection factor 5–10%) 35 m below. Th reflection factor can be increased by using a parabol reflector behind the spark source. H. J. H. STARK

534.88 : 531.76

Measurement of short time intervals, with particula application to distance measurement by sound ech methods. *See Abstr.* 8250

OPTICS . RADIATION . SPECTRA 535

535.23.0

8301. Experimental investigation of the bismut bolometer and theoretical explanation of the result G. C. MÖNCH, G. WICHERT AND O. BÖTTGER. *Ann Phys.* [*Leipzig*] **12**, *No.* 4–6, 183–221 (1953) *In Germa*

After considering the energy balance of a bolo meter, the construction of a particular type is give in detail. The metal is evaporated on to a celluloi film base, suitable stencils being used to give th desired shape. Electrodes are formed by increasin the thickness of the metal over certain regions. cathode-ray oscillograph is used as an indicator an the effects of gas pressure, thickness of metal layer thickness of base film and other factors are measure and discussed. The time factor was investigated b irradiating the bolometer through rotating shutter having various cut-away areas. Finally this instru ment is briefly compared with other types of radiatio receiver. E. H. DOC

535.24 : 536.5.08 : 536.6

Fundamental metrological work in photometry. *Se Abstr.* 8383

535.24 : 621.327.4

8302. Photometry of fluorescent lamps. H.-C FRÜHLING AND J. MARTERSTOCK. *Lichttechnik*, 5 186–8 (*June*, 1953) *In German.*

Describes methods used for measuring luminou intensity, light distribution and luminous flux fro fluorescent lamps and for making the associate electrical measurements. The effect of ambie temperature on the various measured quantities ha received special attention and is shown graphically. J. W. T. WALS

535.241.15

303. A new solution of the problem of attenuating minances. G. BLET. *Rev. Opt.*, **32**, 204–12 (*April*, 953) *In French.*

For certain techniques, there is a need for variable minances, precisely known and reaching very low vels. The various solutions used at present are all convenient. The author proposes a new solution, hich is simple and not bulky, permitting a consider- ble attenuation (>10 000 in the prototype) which llows an exponential law. It is based on the rogressive attenuation of a light beam by multiple iffusion in a tube of variable length. A.

535.247 : 778.34

304. Photometric measurements of the ionization f tracks in photographic plates. G. KAYAS AND D. IORELLET. *J. Phys. Radium*, **14**, 353–61 (*June*, 1953) *n French.*

A description is given of a photoelectric apparatus or measuring the grain density of the tracks of harged particles recorded in nuclear emulsions. The chnique of using the apparatus, including the arious corrections to be applied, is discussed in etail. A. C. COATES

535.247.4

305. An omnidirectional photometer of small dimen- ons. R. G. GIOVANELLI. *J. sci. Instrum.*, **30**, 26–8 (*Sept.*, 1953).

This omnidirectional photometer is intended for the easurement of daylight under grass swards; but the rinciple used in the instrument can be applied to easure the mean illumination at a point in other ases, for example, interior illumination. It consists f two small circular barrier layer cells, insulated from ne another and mounted back to back, each being urmounted by a translucent diffusing hemispherical hell, dia. $\frac{5}{8}$ in. The cell sensitivities are adjusted lectrically to equality, the combined output being ead on an indicating meter. Even for collimated ght the response is uniform with orientation to better han ±5%. A.

535.247.4 : 621.317.79

306. A direct-reading microdensitometer. R. I. AIT AND F. C. CHALKLIN. *J. sci. Instrum.*, **30**, 268–70 *Aug.*, 1953).

The instrument gives galvanometer readings which re directly proportional to the density of the photo- raphic plate under examination and are independent f fluctuations of the light source. This result is chieved by making appropriate use of a logarithmic riode amplifier. High gain is attained by measuring he intensities of the transmitted and the direct beams f light by an electron-multiplier phototube, any atigue effects being avoided by employing the same hototube for both beams. A.

535.317.5

307. Focuses of best sharpness and best resolution or an objective having aberration of the 3rd order. C. DUPOUY-CAMET. *Rev. Opt.*, **32**, 454–74 (*Aug.–Sept.*, 1953) *In French.*

A study of the focusing planes giving either the best esolution or the sharpest image within the caustic of a lens with spherical aberration between $\Delta = \lambda$ and $\Delta = 6\lambda$. The case is considered for single tests (line or disk), of two parallel lines, of periodical tests (Foucault test or indefinite test), and also the case of the image of any landscape, for contrasts between 1 and 0·08. The focusing of an instrument or a lens with spherical aberration, for the greatest sharpness, will be always accurate whatever the test or contrast, with the only condition that for a periodical test of high contrast, the period is at least double the limit of resolution. This focusing gives the best limit of perception, except for periodical tests with contrast higher than 0·3. A.

535.323 : 537.311.33

8308. The change of the refractive index of semi- conducting film irradiated by intense light. K. ISHI- GURO. *J. Phys. Soc. Japan*, **8**, 269–70 (*March–April*, 1953).

Changes are reported in the optical thickness of thin films of Ge, ZnS, CdS produced by intense light radiation. Film thickness was measured by multiple- beam interference. Changes up to 5% in refractive index are reported. The effect is larger for irradiation from the glass substrate side than for irradiation from the air side. Time lag is several tenths of a second. It is established that the effect is not due to heating. S. TOLANSKY

535.323 : 539.232

8309. The refractive index and thickness of thin anodically formed aluminium oxide films. R. BAHN AND O. BÖTTGER. *Z. Phys.*, **135**, *No.* 4, 376–9 (1953) *In German.*

Thickness and refractive indices are measured by using a modified Kösters interferometer. It is found that the thickness does not increase in a linear manner with the oxidation voltage. Measurements are re- ported for thickness up to about 300 mμ. The refrac- tive index found interferometrically is independent of the oxidation voltage (which was varied from 0 to 200 V) and is given as 1·535 ± 0·005. S. TOLANSKY

535.33

8310. Spectroscopy from the point of view of the communication theory. II. Line widths. A. G. EMSLIE AND G. W. KING. *J. Opt. Soc. Amer.*, **43**, 658–63 (*Aug.*, 1953).

For Pt I, see Abstr. 6100 (1951). A spectrum can be considered as a signal composed of a superposition of randomly-spaced Cauchy lines of the form $\delta^2/(\delta^2 + x^2)$. This signal is passed through a spectro- scope which acts as a noisy channel causing distortion due to finite aperture, slits, prism absorption, and elec- trical bandwidth. The loss of information in the Hartley sense can be described by the increase in width of lines in the output signal. Several definitions of line widths are compared for ease in experimental measurement and calculation as functions of δ and the instrument characteristics. The different widths do not vary in the same manner over the range of experi- mental conditions. In particular the resolution width departs markedly from the others. Because the intensity distribution is very complicated, the width at half-height and the median width are difficult to calculate. The latter is approximately the same as the root-mean-square width which can be more readily calculated. The most satisfactory width for both

experimental and theoretical determination seems to be that of the equivalent Cauchy line shape. This is easy to measure from the observed area, which is merely a product of elementary functions and the filter characteristic. A.

535.33

8311. Spectroscopy from the point of view of the communication theory. III. The amount of information in a spectrum. G. W. KING AND A. G. EMSLIE. *J. Opt. Soc. Amer.*, **43**, 664–8 (*Aug.*, 1953).

The spectroscope is considered as a communication channel. The message space is the class of all possible spectra, which are essentially sets of randomly spaced delta functions of Gaussian amplitude distribution. Hence the capacity of the channel can be evaluated by Shannon's formula,

$$C = \frac{1}{2\pi}\int_0^2 d\tau \log_2\{1 + d^4[2\rho E^2/N_0] [\sin d\tau/d\tau]^4[(2-\tau)/4]^2\}$$

bits per diffraction unit, where d is the slit width, ρ the density of lines, E the intensity with unit slit, N_0 the noise power in the band $0 \leqslant \tau \leqslant 2$, determined by the aperture. This integral rises rapidly to a constant value, indicating that the choice of d need only be based on ease of interpretation. An equivalent width τ_C in frequency space is defined, which includes most of the integrand of C, and to which there corresponds an information half-width $a_C = \pi/2\tau_C$ which measures the resolution in the presence of noise. The most suitable experimental conditions are when $a_C \sim a_c$, the Cauchy half-width, which occurs when the noise is about 5% of the signal and two readings are taken per slit width. By the conventional interpretation the amount of information in a spectrum of length Δx is measured by Hartley's formula as $\Delta x/2a_C$ bits of position information. The ratio of the maximum amount to this is $2a_C C$, which, in a typical case, amounts to a factor of 4 in resolution if a suitable decoding or filtering procedure could be discovered. A.

535.33.07–15

8312. A double-beam system for infra-red spectrometers employing rotating twin cells. N. H. E. AHLERS AND H. P. FREEDMAN. Letter in *Nature* [*London*] **172**, 260–1 (*Aug.* 8, 1953).

Additions to a Perkin Elmer instrument permit direct recording of % transmission. G. F. LOTHIAN

535.33.07–15 : 541.124

Application of a fast-scanning infrared spectrometer to gas-phase kinetic studies. *See Abstr.* 8731

535.338.3

8313. Forbidden transitions in the palladium I spectrum. A. G. SHENSTONE. *Proc. Roy. Soc. A*, **219**, 419–25 (*Oct.* 7, 1953).

A new examination of the palladium arc spectrum has resulted in the discovery of a type of forbidden transition which has not previously been observed. The level K_1, in particular, is shown to give many more forbidden than allowed lines. The explanation is in the theory of "forced" dipole radiation, a type of Stark effect which is due to the interionic fields in the arc. Additions to the analysis of Pd I are also given. A.

535.338.

8314. Hyperfine structure of the spectrum of Al II. S. SUWA. *J. Phys. Soc. Japan*, **8**, 531–4 (*July–A* 1953).

For Pt I, see Abstr. 3441 (1952). As a supplem to the previous work on the anomalous h.f.s. of spectrum of Al II, the structure of the multi $\lambda 3587{\cdot}4 - \lambda 3586{\cdot}5$ ($3^3D - 4^3F$) was studied. calculated structure of this multiplet was found to in harmony with that observed by means of interfe meters. The triplet separations $\alpha = 3^3D_3 - 3^3D_2$ $\beta = 3^3D_2 - 3^3D_1$ were found to be $-2{\cdot}20$ cm and $-1{\cdot}02$ cm^{-1} respectively (the 3^3D term being verted). The hyperfine energy levels of the n ($n = 3, 4, 5$) series are represented diagrammatic to show how they depart from the ordinary coupl $\{(L.S)J.I\}$ progressively towards the coupl $\{(S.I)U.L\}$, as n increases.

535.33

8315. Analysis of the $^2\Pi$–$^2\Sigma$ bands of the N_2^+ mo cule. A. E. DOUGLAS. *Astrophys. J.*, **117**, 38 (*May*, 1953).

The 2–0, 3–1, 4–2, and a part of the 1–0 bands the $A^2\Pi$–$X^2\Sigma$ system of N_2^+ have been measured a analysed. Using the most probable vibratio numbering, the following constants have been de mined for the $^2\Pi$ state: $B_e = 1{\cdot}722$; $\omega_e = 1902$ $\omega_e x_e = 14{\cdot}91$; $A_e = 81{\cdot}65$; $T_e = 9168{\cdot}4$ cm^{-1}.

535.33

8316. The wavelengths of nitrogen First Posit bands. D. SAYERS AND P. K. CARROLL. Note *Proc. Phys. Soc.* [*London*] *A*, **66**, 577–8 (*June*, 1953).

Wavelengths of the P_1 heads of the 0,0, 6,7, 2,2, 4,4 and 5,5 bands are given. R. F. BARR

535.338.4

8317. The ultra-violet band spectrum of carb monoselenide. R. K. LAIRD AND R. F. BARRO *Proc. Phys. Soc.* [*London*] *A*, **66**, 836–9 (*Sept.*, 195

An improved source of the CSe band system emission has been discovered which has enable partial rotational analysis of seven bands to be ma The value derived for r_e'' is $1{\cdot}67$ Å. No evide against the view that the main system is $^1\Pi$–$^1\Sigma$, which the $^1\Pi$ state is greatly perturbed, has b obtained.

535.338.4

8318. Extension of the N_2^+ ($C \rightarrow X$) bands in far ultraviolet region. Y. TANAKA. Letter in *J. che Phys.*, **21**, 1402–3 (*Aug.*, 1953).

The system was studied in condensed and unco densed discharges through N_2 and NO and with as diluent. Measurements are tabulated. The ca of the vibrational intensity anomalies are discusse the strengthening of bands with $v' \geqslant 3$ in He attributed to inverse predissociation, using $D(N_2)$ $9{\cdot}764$ eV. A. G. GAYD

535.

8319. Splitting of absorption bands of excess me in sublimed salt films. P. N. KOKHANENKO A V. D. GOL'TSEV. *Dokl. Akad. Nauk SSSR*, *No.* 3, 543–5 (1952) *In Russian.*

Zn and Cd were separately introduced into films $CuCl_2$, CuI and AgI (containing excess Cu or Ag)

h a way that their concentration progressively in-ased in the film in a direction parallel to that of the ctrograph slit, so that the effect of this increase on absorption spectra of the films at ordinary tem-rature and −180°c could be followed. The intro-ction of these foreign metals in addition to the sting Cu or Ag (host) metal excess, causes weaken-, displacement, and in some cases disappearance principal absorption bands of the host metals, and subdivision of others (doublets) into systems of o separate bands, while new bands appear, due her to the host or foreign metal, and these are in veral cases split into two components as the quantity foreign metal increases. In general these pheno-na can be interpreted by Bethe's theory, making e of forbidden transitions of electrons in neutral oms, e.g. new bands appearing in the $CuCl_2$ spec-m can be ascribed to $3d\ ^2D_{3/2} \rightarrow 5s^2S_{\frac{1}{2}}$ and $^2D_{5/2} \rightarrow 5s\ ^2S_{\frac{1}{2}}$ transitions. However, the unusual arpness of some of the bands, and the occurrence selective reflections can only be explained by elec-n transition in ions of the excess host or foreign tal. R. C. MURRAY

535.343–14/15 : 537.226

20. Investigations in the region of tenth-millimeter waves. R. MEIER. *Ann. Phys.* [*Leipzig*] **12,** p. 1–3, 26–34 (1953) *In German.*

Details are given of the construction of a grating ectrometer for 0·15–0·6 mm wavelengths. Atmo-heric water vapour lines are resolved, e.g. 0·190 mm m 0·213 mm. The fall of dielectric constant of roelectric titanates, "Condensa" and "Epsilan" is tained from the reflection spectra; e.g. the high Ba ntent Epsilan has $\varepsilon = 7000$ (d.c.) 700 (at 0·410 mm) (at 0·150 mm). D. H. WHIFFEN

535.343–14

21. Pure quadrupole spectra: alkyl bromides and dides. H. ZELDES AND R. LIVINGSTON. Letter in *chem. Phys.*, **21,** 1418–19 (*Aug.*, 1953).

Coupling trends for bromides and iodides are very milar to those of chlorides, suggesting a similarity bond types, and close values of electronegativity. J. JACOBS

535.343.2

22. Photochemical coloration of ammonium lides. H. RÜCHARDT. *Z. Phys.*, **134,** *No.* 5, 554–63 953) *In German.*

X-ray coloured NH_4Cl and NH_4Br crystals show a oad absorption band at 3·25 eV (3800 Å) which is dependent (in position and form) of temperature. uantum yield and saturation limit increase with ecreasing temperature. The results indicate that -type centres are not formed, the band being asso-ated with NH_4^+ ions which have captured an electron become neutral. G. F. J. GARLICK

535.343.2–32

23. Additional study on the absorption spectrum f solid nitrous oxide in the Schumann region. J. RANIER-MAYENCE AND J. ROMAND. Letter in *J. hys. Radium*, **14,** 428–9 (*June*, 1953) *In French.*

See Abstr. 1520 (1953). The observations have ow been repeated at 20°K, other conditions remaining ne same. The B band (2000–1600 Å) is only slightly hanged compared with its appearance at 60°K. Increased absorption is probably explicable by diffusion, this occurring even for visible wavelengths. At wavelengths >2000 Å, the same irregular phenomena were observed as at 60°K. There is a slight general increase in absorption which is much more marked at the longer wavelengths. This suggests that the hitherto unassigned absorption region 2000–2400 Å may be due to NO formed by photochemical dissociation. This has never been reported to occur in the gaseous phase, but it might happen under the experimental conditions. N_2 and O_2 might also be formed. Around the absorption maximum at 1780 Å there are weak variations in intensity, separated by about 30 Å. A. J. TAYLOR

535.343.9

8324. Reflection spectra of powders. G. KORTÜM AND P. HAUG. *Z. Naturforsch.*, **8a,** 372–9 (*June*, 1953) *In German.*

Discusses and develops in many respects the method of taking absorption spectra by reflection from substances in powdered form. The conducted investigation refers to: validity of the Lambert cosine law, polarization of the diffuse scattered radiation, possibility of using different standards of comparison, and the dependence of the spectra on the grain size. Evaluates from empirical results the limits of error for the relative and absolute measurements. The transmission and reflection spectra of diphenyl at different temperatures are given as an example for the applicability of the method to the problems of molecular structure. F. LACHMAN

535.345

8325. The continuous absorption of light in magnesium vapour. R. W. DITCHBURN AND G. V. MARR. Note in *Proc. Phys. Soc.* [*London*] *A*, **66,** 655–6 (*July*, 1953).

Graphical results are given of measurements of the absorption cross-section for Mg vapour in the region of the series limit over a range of pressures from 0·5 to 1·3 mm. No trace of molecular absorption has been detected. Near the limit, the absorption falls off more rapidly than is predicted for Be and Ca, and the cross-section seems to vary with λ^{15}. F. LACHMAN

535.345.6

8326. Narrow pass band optical filters. D. T. TURNBULL. *Lab. Pract.*, **2,** 480–7 (*Sept.*, 1953).

The interference type with metallic reflecting surfaces is used most frequently; improvement in performance may be brought about by using the all-dielectric type of filter and this modification seems to offer the greatest possibilities for work in the infrared. For extremely narrow pass bands the costly and somewhat elaborate polarization filter has to be used. Christiansen filters may be used over a very wide spectral range but their use is limited by their low contrast ratio and the need for temperature control. A.

535.345.6 : 535.24 : 535.6.08

8327. Application of interference filters to photometry and colorimetry. M. ARTOM, C. M. GARELLI AND C. GENTILE. *Nuovo Cimento*, **10,** 827–34 (*June*, 1953) *In Italian.*

The applicability of the wedge interference filter

proposed by Dufour and Turner is discussed. A method for obtaining a filter of assigned spectral transmission curve by means of a properly shaped template placed on the wedge is investigated. A mathematical procedure for calculating the shape of such a template is derived and the computation carried out for the case of a filter of constant transmission over a given spectral range in the visible region. A.

535.347–15 : 541.65

Infra-red dichroism in synthetic polypeptides. *See Abstr.* 8752

535.37

8328. Luminescence of atomic and ionic silver centres in NaCl–Ag phosphors. M. L. KATS. *Dokl. Akad. Nauk SSSR*, **85**, *No.* 3, 539–42 (1952) *In Russian.*

Very pure monocrystals of NaCl containing AgCl, first irradiated with X-rays, emit, after excitation by u.v. light (Hg-quartz lamp; 2400–3800 band, with maxima at 2750 and 3400 Å) a fluorescence which is orange at ordinary temperature, and yellowish-green at 200–250°, and a phosphorescence—blue with max. at 4500 Å and simultaneously u.v. with max. at 2480 Å. This indicates that X-rays produce atomic Ag centres, responsible for fluorescence, from ionic centres, responsible for fluorescence, an interpretation supported by observations on the behaviour of the phosphors when not X-irradiated, by the continuous decrease of the phosphorescence intensity with time of irradiation, whereas that of the fluorescence increases to a "saturation" max. and then falls, and by the much weaker colouring of NaCl–AgCl phosphors by X-rays than that of pure NaCl. A scheme of electron levels which could account for the phenomena is discussed. R. C. MURRAY

535.37

8329. On Tl^+ in alkali halides. P. BRAUER. Note in *Z. Naturforsch.*, **8a**, 273–4 (*April*, 1953) *In German.*

535.371

8330. The influence of an electric field on a continuously excited phosphor. F. MATOSSI. Note in *Naturwissenschaften*, **40**, *No.* 8, 239–40 (1953) *In German.*

535.371

8331. On the diminution of luminescence as a result of electron irradiation. K. H. J. ROTTGARDT. *Naturwissenschaften*, **40**, *No.* 11, 315–16 (1953) *In German.*

The phenomena associated with the "magic eye" valve used in radio are investigated systematically for a typical Group II halide, ZnF_2, activated with manganese. The experimental results are compared with an equation due to Bröser and Warminsky (1951). C. A. HOGARTH

535.371

8332. Measurements of scintillation lifetimes. H. B. PHILLIPS AND R. K. SWANK. *Rev. sci. Instrum.*, **24**, 611–16 (*Aug.*, 1953).

A pulsed X-ray method for measuring the decay time of luminescence of organic scintillators is described. The design of the X-ray tube and the arrangement of the accompanying electrical apparatus is outlined. Particular care was taken to minimize the time dispersion effect of the apparatus and increase the pulse size of the scintillation in or that statistical fluctuations would be minimized. luminescence decay curves for anthracene, stilb and diphenylacetylene scintillators are shown.

535.371 : 536.49 : 534.3

8333. Visible indication of heat and ultrasc radiation by means of organic phosphors. H. CHOI W. HOFFMANN AND P. SEIDEL. Note in *Na wissenschaften*, **40**, *No.* 10, 288–9 (1953) *In Germa*

The temperature quenching of fluorescence borates and phosphates, containing sodium fluores as activator, is applied to the detection of tempera contours on surfaces, and interference patterns ultrasonic fields. G. F. J. GARL

535.371 : 537.533 : 5

8334. Field emission of crystal phosphors. UETA. Note in *J. Phys. Soc. Japan*, **8**, 429–31 (*M June*, 1953).

An extension of the work of Gudden and Pohl Destriau [*J. Phys. Radium*, **1**, 51–5 (*Feb.*, 1940)]. simple cell and measurements of luminescent intens applied voltage and depth of activation levels phosphors excited by strong electric fields described. The results indicate that the emissio due to the removal of electrons from impurity cen by a field emission process. C. G. MOR

535.3

8335. A note on the Raman spectrum of thianth in solution. L. SINGH. Letter in *Nuovo Cimento*, 89 (*Jan.*, 1953).

The Raman spectra of thianthrene in solution CS_2 and in the solid state suggest that dimerizatio induced in solution by the incident radiation. G. I. W. LLEWE

535.375.5 : 5

8336. Raman effect in solids. A. C. MENZ *Rep. Progr. Phys.*, **16**, 83–107 (1953).

A summary is given of the early work in this fi followed by an outline of the theoretical treatmen vibrations in crystals. The alkali halides h received a somewhat more detailed treatment t other substances. A bibliography is appen (218 entries), giving references to papers cove more especially the last five years.

535.37

8337. Raman spectrum of gaseous ethforane. J NIELSEN AND C. W. GULLIKSON. Letter in *J. ch Phys.*, **21**, 1416 (*Aug.*, 1953).

The spectrum of gaseous C_2F_6 at 30°C in frequency range 348–1420 cm^{-1} is tabulated compared with the Raman spectrum of liquid C at −78°C previously recorded. G. I. W. LLEWE

535.

8338. Light output of potassium iodide crys under bombardment by heavy charged partic W. T. LINK AND D. WALKER. Note in *Proc. P Soc.* [*London*] *A*, **66**, 767–70 (*Aug.*, 1953).

Reports measurements of the relative light out (accurate to 2%) of KI(Tl) crystals as a function of incident energy (accurate to 1% of maximum ener for protons, deuterons and α-particles up to ener of 10, 20 and 40 MeV respectively. In all cases

ation between light output and particle energy was nd to be non-linear over part of the range. The iciency of the crystal exhibits a maximum at a value the specific energy loss equal approximately to that a 30 MeV α-particle. J. DUTTON

535.376

39. Scintillations produced by alpha particles in I. B. HAHN. Letter in *Phys. Rev.*, **91**, 772 (*Aug.* 1, 53).

The absolute efficiency of luminescence in un-tivated CsI at 77°K bombarded by α-particles is %, an abnormally high value, the emission being the blue region. The 5·3 MeV Po α-rays give a ulse distribution with a width of 5% at half maximum presenting 1000 photoelectrons per MeV. Response linear with energy above 2 MeV. G. F. J. GARLICK

535.376

40. Fluorescent light yield with alpha, beta, and mma radiations. M. FURST AND H. KALLMANN. tter in *Phys. Rev.*, **91**, 766 (*Aug.* 1, 1953).

535.376

41. Fluorescence characteristics of mixed organic ystals. G. T. WRIGHT. *Proc. Phys. Soc.* [*London*] *A*, 5, 777–83 (*Sept.*, 1953).

Experiments with mixed crystals of anthracene in aphthalene are described. A fluorimeter technique used to measure crystal concentrations, and it is ound that considerable purification of the melt occurs uring crystallization. No significant difference is bserved in the relative fractional intensity of each uorescence component for excitation with 2540 Å adiations and with α-particles. A simple theory is ormulated and agrees well with the experimental ata. The equations obtained are used to explain the ecrease in radioluminescence efficiency of organic hosphors due to radiation damage, and it is estimated hat for anthracene each 5 MeV α-particle absorbed roduces approximately 2×10^4 effective non-radiative issipative centres. A.

535.379

342. Chemiluminescent phenomena during hydro-arbon combustion. R. G. W. NORRISH, G. PORTER ND B. A. THRUSH. Letter in *Nature* [*London*] **172**, 1–2 (*July* 11, 1953).

Rapid changes in absorption and emission curves n selected spectral regions have been recorded by hoto-electric methods. Peaks of microseconds uration have been observed superposed upon the ee radical spectra. These cannot be due to a rapid ncrease and decay in radical concentration, but are ttributed to chemiluminescent processes of duration hort compared with that of the whole combustion. H. H. GREENWOOD

535.39 : 539.234

3343. Coefficients of reflection and transmission of very thin metallic films. New method for determining heir indices and thicknesses. F. ABELÈS. *Rev. Opt.*, 32, 257–68 (*May*, 1953) *In French.*

Expressions for the reflectances R and R' and the transmittance T of thin films as the quotient of power series in $\gamma = 4\pi d/\lambda$ (d = thickness of the film, λ = wavelength of the incident vibration). If the powers of γ up to the third are taken into account, the parameters of the film can be derived from the measurements of R, R' and T by resolving a cubic algebraic equation. The results obtained are valid as long as $n\gamma < 1$ and $k\gamma < 1$, $n - ik$ being the complex refractive index of the film. A.

535.417 : 531.715.1 : 535.33.07

8344. A spectrograph unit for use with the N.P.L. gauge interferometer. C. F. BRUCE AND V. R. FINDLAY. *J. sci. Instrum.*, **30**, 297–9 (*Sept.*, 1953).

The unit enables photographic recording to be used satisfactorily in the routine determination of length in terms of cadmium light waves with this interferometer. The time taken to record and measure is no longer than that taken with the normal visual method and the photographic method has advantages of permanent recording, reliability of measurement and lower fatigue effects on observers. The unit can also be used very effectively for improved visual observation. The present unit is primarily designed for dispersing the cadmium radiations satisfactorily and does not, for example, separate adequately the two mercury yellow lines 5791 Å and 5770 Å. A.

535.421

8345. Wadsworth mounting for grating. A. G. SHENSTONE. Letter in *J. Opt. Soc. Amer.*, **43**, 706 (*Aug.*, 1953).

It is pointed out that the focal curve for a Wadsworth-mounted grating approximates to a circle for small angles about the grating normal. The approximation is within experimental focusing errors for a field of ±8° for a 21 ft grating. An expression for the radius of curvature is given. D. G. AVERY

535.55

8346. Photo-elastic effect in lead nitrate. S. BHAGAVANTAM AND K. V. KRISHNA RAO. *Nature* [*London*] **172**, 415 (*Aug.* 29, 1953).

The effect is similar to that for barium nitrate [Abstr. 552 (1949)]. The differences between the stress-optical constants for sodium D lines are $(q_{11} - q_{12}) = -19{\cdot}13\times10^{-13}$, $(q_{11} - q_{13}) = -11{\cdot}84\times10^{-13}$ and $q_{44} = -1{\cdot}393\times10^{-13}$. H. G. JERRARD

535.55

8347. A method of correcting for initial stresses in frozen-stress observations. H. T. JESSOP AND W. H. STABLEFORD. *Brit. J. appl. Phys.*, **4**, 281–3 (*Sept.*, 1953).

Formulae are derived by the use of which it is possible to correct observations on a slice of a "frozen" model for such initial stresses as cannot be removed by annealing. It is demonstrated also that mottle in Marco resin produces an optical effect similar to that of a stress-difference, and that this method of correction may be applied to mottle effects when these are sensibly uniform through the thickness of a slice of the material. A.

535.642

8348. Simple graphic method for the additive mixture of two colors on the CIE chromaticity diagram. H. VON SCHELLING. Letter in *J. Opt. Soc. Amer.*, **43**, 706–7 (*Aug.*, 1953).

Gives a graphical method for determining the chromaticity co-ordinates (x, y) of a mixture containing two stimuli of known tristimulus values $(X_1, Y_1, Z_1$ and $X_2, Y_2, Z_2)$ in a given proportion [see Abstr. 1439 (1945)]. J. W. T. WALSH

535.65 : 535.345.6

8349. Alteration of the relative brightnesses of colours by neodymium filters. C. SCHAEFER AND J. EBERLE. *Optik*, **10**, *No.* 6, 305–15; *No.* 7, 317–29 (1953) *In German.*

A filter containing neodymium is dichroic, with a region of high absorption factor in the yellow. If two colours are viewed through such a filter, their relative intensities might be altered by an amount sufficient to make the use of neophane spectacles, for instance, useful in the discrimination of colour signals. The matter is examined in this paper, both by calculation from spectral data and by heterochromatic photometry, using for the colours 24 samples from circle *ia* of the Ostwald colour atlas. It is concluded that, although the contrasts between certain colours in the region between yellow and red are somewhat increased, no general improvement of colour contrast can be obtained by the use of this type of filter.

J. W. T. WALSH

535.68 : 551.593

8350. The atmospheric light and its influence on colours in the landscape. A. WENZEL. *Optik*, **10**, *No.* 7, 330–8 (1953) *In German.*

From previous workers' data on the spectral distribution of daylight, calculations have been made on the light emitted by various thicknesses of air, so deriving the dominant hue of the light, its saturation, its brightness as a percentage of the horizontal brightness and its chromaticity in the MacAdam UVW system. In most cases the chromaticity lies in the sector between 4800 and 4900 Å. Spectral extinction coefficients were determined and used to estimate the colour changes in the Ostwald *pa* circle when viewed through increasing thicknesses of air. The circle contracts till at 25 km the hues are scarcely distinguishable from the colour of the horizon.

S. T. HENDERSON

535.7 : 612.84

Physiological optics. *See Abstr.* 8825–8

535.82 : 535.41

8351. Interferometry by polarization in reflected light. M. FRANÇON. *Rev. Opt.*, **32**, 349–57 (*June*, 1953) *In French.*

Describes the principle of two interferometers specially designed for the study of macroscopic reflecting objects. In the first, stray light should be avoided. The second one is more luminous and can be made very simply. [See also Abstr. 3525 (1952)]. A.

535.822

8352. Photomicrography without an eyepiece. F. BODE. *Z. wiss. Mikr.*, **61**, *No.* 6, 350–4 (1953) *In German.*

The photograph obtained from the primary image formed by a microscope objective may sometimes have better definition and contrast than that from the secondary image formed by a lower powered objective and eyepiece. Sample photographs illustrate this.

R. W. FISH

535.827.14 : 621.316.71

8353. An electric micromanipulator. V. BUSH, W. R. DURYEE AND J. A. HASTINGS. *Rev. sci. Instrum.*, **24**, 487–9 (*July*, 1953).

Consists of 4 electrically operated toolholders, each suspended under spring loading by therm expansion wires. In turn, these are controlled variable transformers operated by two joystic Selector switches determine which toolholder be influenced by either joystick. Ratio control tra formers in the 110 volt, line-operated power allow an operator precise, normalized, 3-dimensio control of the microtools, viewed under any magnifi tion of the compound microscope. In additio joystick control covering the microrange of 0·5 400 microns, each toolholder has 3 sets of mechan controls to allow coarser adjustments for the ra of 0·1 to 10 mm. Magnetic chucks and other c veniences for the observer have been provided.

HEAT 536

536.2

8354. The part of thermal radiation in the therm conduction process. L. GENZEL. *Z. Phys.*, **135**, *No* 177–95 (1953) *In German.*

It is considered that the normal simple differen equation cannot truly explain the complicated proc of thermal conduction. This is especially so when conduction coefficient varies with temperature. energy transport is considered under various c ditions and calculated on the basis of the Kirch formula, and the results for diffuse radiation expressed graphically. The absorption of the in vening medium and the properties of the surfaces taken into account and the energy exchange is gi in terms of radiation conduction and true therm conduction.

E. H. DC

536

8355. A problem in heat conduction and its solut by means of Hankel transforms. H. DELAVAU *C.R. Acad. Sci.* [*Paris*] **236**, 2484–6 (*June* 29, 1953) *French.*

The equation of heat conduction in a solid boun by two parallel planes $z = 0$ and $z = l$, is solved the case of cylindrical symmetry, the integral of temperature function $f(t, r, z)$ being absolutely c vergent in the interval $0 \leqslant r \leqslant \infty$, the function it being of bounded variation in this interval a developable as a Fourier series with respect t in $(0, l)$.

T. P. BRC

536.25 : 532.5 : 550.

8356. The onset of convection by thermal instabil in spherical shells—(a correction). S. CHANDRASEKH *Phil. Mag.*, **44**, 1129–30 (*Oct.*, 1953).

See Abstr. 4053 (1953).

536.413.2 : 538.

8357. Magnetic moment orientation and therm expansion of antiferromagnetic CrSb. A. I. SNO *Rev. mod. Phys.*, **25**, 127 (*Jan.*, 1953).

Describes results of X-ray measurements of th and *a* axes of CrSb between room temp. and 800 There is a discontinuity in slope at 450°C, the a ferromagnetic transition temperature. The results related to neutron diffraction data giving the relat alignments of the atomic moments of the Cr ato [Abstr. 3702 (1952)].

E. P. WOHLFAR

536.421.1

8358. Measurement of the melting temperature of metals at very high pressures. V. P. Butuzov, M. G. Gonikberg and S. P. Smirnov. *Dokl. Akad. Nauk SSSR*, **89**, *No.* 4, 651–4 (1953) *In Russian.*

Describes apparatus for heating metals up to 500°C under pressures up to 22 000 kg/cm². Arrangement avoids attack of pressure vessel by hot metal. M.pt. of bismuth falls from 271°C at atm. press. to 97°C at 15 700 kg/cm² in close agreement with Bridgman. Extension of observations to higher pressure reveals transformation from bismuth I to bismuth II with triple point at 17 400 kg/cm² and 36°C. J. W. MENTER

536.423.15

8359. Calculation of the vapour pressure of water from 0° to 100°C; formula for this pressure between −20° and +200°C. Volume of the vapour. Heat of vaporization. J.-P. E. Duclaux. *C.R. Acad. Sci. [Paris]* **236**, 2218–19 (*June* 8, 1953) *In French.*

Uses the formula given in Abstr. 7625 (1953) to calculate the vapour pressure, and finds satisfactory agreement with experiment. L. G. CARPENTER

536.423.15

8360. The accuracy of the Knudsen effusion method for measuring vapor pressures. M. G. Rossman and J. Yarwood. Letter in *J. chem. Phys.*, **21**, 1406–7 (*Aug.*, 1953).

It is considered that the geometrical treatment of the effusion method given by Whitman [Abstr. 2668 (1952)] is not applicable and a simpler treatment is outlined. It is deduced that the effective area of the condensate is fundamentally related to the pressure of the effusing gas, contrary to Whitman's conclusion. S. WEINTROUB

536.423.15

8361. Comment on "The accuracy of the Knudsen effusion method for measuring vapor pressures." C. I. Whitman. Letter in *J. chem. Phys.*, **21**, 1407 (*Aug.*, 1953).

See preceding abstract. Whitman states that Rossmann and Yarwood's derivation is similar to that of Speiser and Johnston [*Trans Amer. Soc. Metals*, **42**, 283 (1950)] and depends on the unjustifiable assumption of a uniform steady-state pressure through the vapour. Whitman contends that Rossmann and Yarwood's conclusion is not in conflict with his own but is exactly the same. S. WEINTROUB

536.424

8362. On the metastable phase change of ammonium nitrate. K. Tanaka and I. Fukuyama. Note in *J. Phys. Soc. Japan*, **8**, 428–9 (*May–June*, 1953).

Results are graphed of measurements showing the relationship between the appearance and disappearance of the metastable transition at 50°C of NH_4NO_3 (from the tetragonal to orthorhombic system) and the characteristics of heat-treatment and the water content of the specimens. F. LACHMAN

536.44

8363. Relation between critical temperature and pressure of normal paraffins. Y. P. Varshni. Letter in *J. chem. Phys.*, **21**, 1400 (*Aug.*, 1953).

For paraffins higher than ethane, $T_c/p_c + 6{\cdot}4 \times 10^6 p_c/T_c$ (with p_c in atm) is constant to within ½%. R. O. DAVIES

536.44

8364. The total energy of substances at the critical point. J. van Dranen. Letter in *J. chem. Phys.*, **21**, 1404 (*Aug.*, 1953).

Continuation of previous papers [Abstr. 8127 (1952), 4057 (1953)]. Further data in support of the hypothesis that the total internal energy at the critical point is zero. R. O. DAVIES

536.44

8365. The critical point and the disturbed rotation of molecules in the liquid state. J. van Dranen. Letter in *J. chem. Phys.*, **21**, 1404–5 (*Aug.*, 1953).

Uses the hypothesis described in the preceding abstract to estimate the rotational kinetic energy of CO_2 at the critical point. The value obtained is 40% of that which would be associated with free rotation. R. O. DAVIES

536.48

8366. Low temperature physics. C. F. Squire. *London: McGraw-Hill Book Company* (1953) x + 244 *pp.*

Topics covered in this text (some theory included) are: gas liquefaction, equations of state, experimental methods, properties of liquid helium, superconductivity, low-temperature magnetism, thermal energy and dielectric properties of solids at low temperatures. There are numerous diagrams and a selection of references to original papers. R. B. DINGLE

536.48 : 536.6

8367. Apparatus for low temperature calorimetry. R. W. Hill. *J. sci. Instrum.*, **30**, 331–4 (*Sept.*, 1953).

A description is given of two pieces of apparatus for the measurement of the thermal properties, particularly the specific heat, of solid samples between 2°K and room temperature. The two machines differ in the method of using liquid helium, one incorporating a liquefier of the Simon expansion type, the other using liquid helium from a separate liquefier. The two methods of working are compared and their relative merits evaluated. A general purpose calorimeter suitable for either apparatus is also described. A.

536.48

8368. Anomalous surface tension in helium II. D. F. Brewer and K. Mendelssohn. Letter in *Phil. Mag.*, **44**, 559–61 (*May*, 1953).

See also Abstr. 4060 (1953). Experiment shows that below the λ-point a large amount of liquid He II is held in 10^{-4} cm gaps between plane circular glass plates. The explanation suggested is that it is energetically advantageous for clusters of bulk liquid to be formed. R. B. DINGLE

536.48

8369. Note on the adsorption of helium on glass. E. Long and L. Meyer. Letter in *Phil. Mag.*, **44**, 788–9 (*July*, 1953).

The results of Brewer and Mendelssohn (preceding abstract) for the amount x of He adsorbed on glass at a number of temperatures below the b.p., and at saturations p/p_0 from 30% to 90%, are examined; it is shown that x increased with temperature in the He II region and decreased in the He I region, with a sharp break at the λ-point. It is contended that this

is inconsistent with the requirements of thermodynamics (Kirchhoff's law and the Clausius–Clapeyron equation) and that it leads to impossibly high values of the entropy of the adsorbed film. S. J. GREGG

536.48

8370. Inconsistencies in adsorption experiments of helium II. D. F. BREWER AND K. MENDELSSOHN. Letter in *Phil. Mag.*, **44**, 789–91 (*July*, 1953).

A reply to Long and Meyer (preceding abstract). It is argued that the criticisms of Long and Meyer arise from their attempt to express the condition of unsaturated He below the λ-point by a simple physical adsorption. It is very probable that in He II the surface phenomena depend on the method of measurement, and the existence of a new effect is tentatively suggested—the formation of small clusters of bulk liquid below saturation pressure—which overlaps and obscures the process of van der Waals adsorption.

S. J. GREGG

536.48

8371. The molecular theory of liquid helium. IV. The cooperative character of the λ-point transition. I. PRIGOGINE AND J. PHILIPPOT. *Physica*, **19**, 508–16 (*June*, 1953) *In French.*

For Pt III, see Abstr. 6723 (1953). The co-operative character of the transition of the λ-point is studied by means of the cell model used by the authors in their previous communications. It is shown that due to a sharp diminution of the excitation energy Δ with an increasing number of fluctuations, the specific heat must present a singularity. The nature of this singularity is discussed. A.

536.48

8372. The vapor pressure and entropy of liquid He^3. D. TER HAAR. Letter in *Phys. Rev.*, **91**, 1018 (*Aug.* 15, 1953).

A plot of $\log(p/T^{5/2})$ against $1/T$, where p is the experimental vapour pressure of liquid He^3 above 1°K, suggests a positive value for the entropy at absolute zero. This agrees with the conclusion of Abraham, Osborne and Weinstock [Abstr. 1805 (1951)] that liquid He^3 must show a transition below 1°K. R. B. DINGLE

536.48 : 532.7

8373. A classical model of a roton. C. L. PEKERIS. *Proc. Nat. Acad. Sci. U.S.A.*, **39**, 443–51 (*March*, 1953).

A "spherical vortex" in which particles of a non-viscous liquid move along helical orbits about a ring-shaped surface, is specified by two parameters such as extension and angular momentum. Using known results of hydrodynamics, the author expresses the energy of the vortex as a function of its linear momentum and the two parameters. This relation is of the form as that applying to Landau's roton which depends, however, on three parameters. The spherical vortex is, by means of Landau's theory, fitted to the empirical temperature-entropy curve of liquid helium and the resulting parameters of the roton can be compared with those obtained by Khalatnikov (given in brackets): roton mass $= 1{\cdot}59m_{He}$ $(0{\cdot}26)$; zero-point energy $= 8{\cdot}93k$ deg $(8{\cdot}9)$; zero-point momentum $= 6{\cdot}26\times10^{-20}$ c.g.s. units (21). R. EISENSCHITZ

536

8374. Experiments with a rotating cylinder viss meter in liquid helium II. A. C. HOLLIS-HALLE *Proc. Cambridge Phil. Soc.*, **49**, *Pt* 4, 717–27 (1953)

Liquid helium II was contained in the annular spa between two co-axial cylinders, the inner of which w suspended by a torsion fibre while the outer w rotated at constant speeds. The torque upon the inn cylinder produced by the rotating fluid was measur for various steady velocities between 0·1 and 3 cm. se and was not found to be directly proportional to t velocity of rotation at any temperature between t λ-point and 1·15°K. This result suggests that th must be some new type of non-linear friction force acting in the liquid, possibly in addition to t Gorter–Mellink force of mutual friction. Extrapo tion of the experimental results to zero velocity gi values of the coefficient of viscosity of the norm component which agree with the oscillating d values between the λ-point and about 1·6°K. At lov temperatures, the present results are significan lower, suggesting, perhaps, that the values of t normal component density used in the analysis the oscillating disk results were too low.

536.

8375. On the hydrodynamics of non-viscous flu and the theory of helium II. III. R. KRONIG. *Physi* **19**, 535–44 (*June*, 1953).

For Pt II, see Abstr. 6721 (1953). It is shown th disregarding irreversible effects, the phenomenologi equations of the two-fluid model of helium II can derived exactly from Landau's kinetic picture in whi this substance is considered at the absolute zero temperature as a non-viscous fluid, subject at high temperatures to wave-like excitations. The d crepancies to which previous treatments seeming gave rise disappear on a more careful analysis of t problem.

536.4

8376. The new adiabatic demagnetization apparat at the National Bureau of Standards. D. DE KLERK A R. P. HUDSON. *Rev. mod. Phys.*, **25**, 292 (*Jan.*, 195

536.4

8377. Magnetic refrigerator for maintaining tem peratures below 1°K. C. V. HEER, C. B. BARNES A J. G. DAUNT. *Phys. Rev.*, **91**, 412 (*July* 15, 1953).

Describes construction and performance of refrigerator maintaining temperatures as low 0·3°K by repeated adiabatic demagnetization of 15 of potassium chrome alum which can be thermal linked to or isolated from (*a*) a liquid helium bath (*b*) the cold reservoir by a super-conducting Pb switc The heat extraction rate was about 2×10^4 erg/cyc and the cycle period as small as 2 min. For theory this machine see Abstr. 1710 (1950). D. SHOENBE

536.5

8378. Measurement of the temperature of dielectri and semiconductors in high-frequency fields. A. NETUSHIL AND A. A. LISENKOV. *Elektrichestvo*, **195** *No.* 2, 42–4. *In Russian.*

The distortion of the temperature field in h heating near the thermocouples is due to a distorti of the electric field configuration. The latter is mai

be ascribed to capacitive currents the magnitude of which depends on the external circuit of the thermocouples and to their location in the field. The use of short thermocouples for temperature measurements in l.f. fields is to be recommended as they minimize field distortion, especially when the galvanometer is connected only at the instant of the measurement proper. If continuous measurement is required, the thermocouples should be located at points at earth potential. If this condition cannot be satisfied, special l.f. filters must be designed and placed at the lead-outs of the thermocouples in order to reduce the capacitive currents to their minimum value. B. F. KRAUS

536.532

8379. Improvements in fine wire thermocouples. H. W. SLATER. Note in *J. sci. Instrum.*, **30**, 293–4 (*Aug.*, 1953).

The midrib of a chicken feather was used to strengthen couples made from 40 s.w.g. wire having compensating leads of 26 s.w.g. wire. The units were coated with Durofix, bound with nylon thread and again coated with Durofix. A bead of Durofix near the junction was used to hold the couple with forceps. Compensating leads up to 100 yd long were stored on a former to avoid breakage. E. H. DOCK

536.532 : 53.088

8380. Sampling errors in radiation measurement using the Moll thermopile method. L. L. FOX, R. C. G. HACKHAM, P. L. PALMER AND D. WHITTAKER. *Brit. J. Appl. Phys.*, **4**, 273–8 (*Sept.*, 1953).

The determination of the radiant heat output from solid-fuel fires requires that the radiation be measured at a number of sampling points on the surface of a hemisphere surrounding the front of the fire. For routine work the number of sampling positions must be kept to the minimum consistent with a reasonable degree of accuracy. This paper describes experiments to compare the measurements given by various sampling arrangements with that given by the "standard" sampling arrangement of 21 Russell latitudes–17 Russell longitudes. The results indicate that it is possible to reduce the number of sampling positions to 5 Russell latitudes–5 Russell longitudes and still retain a sampling accuracy of the order of 1%. A.

536.532 : 537.32

8381. Thermo e.m.f. Te/metal. (Experiments on the properties of tellurium/metal assemblies as fast thermoelements.) G. C. MÖNCH. *Ann. Phys. Leipzig*] **12**, *No.* 4–6, 161–74 (1953) *In German.*

Methods of depositing thin Te/metal film thermocouples on celluloid substrates and the construction of sensitive cells are described. Results of measurements of resistance, thermo-electric power and sensitivity, are recorded for many cells. The diffusion of Ag into Te is studied. C. A. HOGARTH

536.532 : 537.32

8382. Thermo e.m.f. Te/Ag. (Experiments on the properties of Te/Ag thermocouples.) T. MOHR. *Ann. Phys.* [*Leipzig*] **12**, *No.* 4–6, 175–82 (1953) *In German.*

See preceding abstract. The preparation and properties of Te/Ag thermocouples are described in detail. C. A. HOGARTH

536.62 : 536.5.08 : 535.24

8383. Fundamental metrological work today in thermology and photometry. E. PERUCCA. *Nuovo Cimento*, **9** (*Suppl. No.* 2) 184–97 (1952) *In French.*

A report of the meeting of consulting committees of the International Bureau of Weights and Measures, held in June, 1952. Deals with thermometry, calorimetry and photometry, and makes recommendations for the next meeting.

536.631 : 536.48

8384. Specific heat of solid oxygen below 4° K. M. O. KOSTRYUKOVA AND P. G. STRELKOV. *Dokl. Akad. Nauk SSSR*, **90**, *No.* 4, 525–8 (1953) *In Russian.*

An improved calorimeter is used in which high vacuum is maintained by means of active carbon at helium temperature. Thermal contact, as necessary for cooling the calorimeter, is temporarily established by means of a metallic junction and by admitting small quantities of gaseous helium. Calorimetric measurements made at 4·2–2·2 and at 2·5–1·2 deg. abs. yield a smooth specific heat curve which fits well to a third power law with $\theta = 126°$. The specific heat curve between 10 and 15°, as obtained by previous authors, leads on extrapolation to a third-power term with $\theta = 133°$ to which a term linear in the temperature has to be added. This apparent discrepancy would be resolved if there is a transformation between 10 and 4°. R. EISENSCHITZ

536.631 : 536.48 : 538.222

8385. Measurement of the nuclear and electronic contributions to the specific heat of neodymium ethyl sulfate near 1°K. L. D. ROBERTS, C. C. SARTAIN AND B. BORIE. *Rev. mod. Phys.*, **25**, 170–3 (*Jan.*, 1953).

The molar specific heat C_I of neodymium ethyl sulphate has been measured on three samples of separated neodymium isotopes in the temperature range 0·95°K–2·15°K by the magnetic method of Benzie and Cooke at frequencies from 300 to 1200 c/s. The measured C_I may be described within 1% by $C_I = b/T^2$, where T is the temperature and b is the constant. All three samples were shown by X-ray diffraction measurements to have the same structure as that given for neodymium ethyl sulphate by Ketelaar. For the electron contribution to the specific heat $b_e = 0{\cdot}146 \pm 0{\cdot}004 \times 10^5$ was obtained, and for the hyperfine splitting contributions $b_{143} = 5{\cdot}08 \pm 0{\cdot}05 \times 10^5$ and $b_{145} = 1{\cdot}7 \pm 0{\cdot}2 \times 10^5$ erg degree. These values of b_{143} and b_{145} agree within experimental error with the corresponding values computed from the microwave measurements of Scovil. Thus, the hyperfine splitting contribution to the specific heat for $Nd^{143}(C_2H_5SO_4)_3 \cdot 9H_2O$ is some 35 times larger than the electron contribution which makes this material of interest for the study of nuclear effects below 1°K. A.

536.631 : 537.311.22 : 548.736.3

Thermal and electrical properties and crystal structure of tungsten oxide at high temperatures. *See Abstr.* 8796

THERMODYNAMICS 536.7/.8

536.7 : 530.12

Thermodynamics in general relativity. *See Abstr.* 8208

536.7 : 541.13

8386. Thermodynamics of irreversible electrochemical phenomena. S. R. DE GROOT, P. MAZUR AND H. A. TOLHOEK. *Physica*, **19**, 549–54 (*July*, 1953).

A discussion from first principles is given of the energy and entropy laws in electrochemical systems. It is found that it is possible to clarify such controversial concepts as the form of the second law and the role of the electrochemical potential in the systems concerned. A.

ELECTRICITY 537

ELECTROSTATICS . DIELECTRICS 537.2

537.226

8387. The properties of colloidal ferroelectrics. I. Potassium phosphate KH_2PO_4. C. JACCARD, W. KÄNZIG AND M. PETER. *Helv. phys. Acta*, **26**, *No.* 5, 521–44 (1953) *In German.*

An isolated and non-conducting ferroelectric crystal of about spherical shape cannot polarize spontaneously, if it is forced to form one single domain. The energy of the surface charges would be larger than the polarization energy. It is to be expected that wall energy prevents a splitting into domains, if the crystal is very small. Therefore a critical crystal size must exist, below which no spontaneous polarization can occur. This effect has been investigated with colloidal KH_2PO_4 by means of X-ray diffraction, electron diffraction, dielectric measurements and electron microscopy. The experiments lead to the conclusion, that KH_2PO_4 crystals imbedded in an insulating medium with an effective dielectric constant $\varepsilon \lesssim 5$ undergo no spontaneous polarization, if the diameter of the crystals is less than 1500 Å. Crystals larger than 4000 Å show normal ferroelectric behaviour. The critical diameter decreases with increasing dielectric constant of the imbedding medium, and if the latter is conducting, even the smallest particles which were produced (500 Å) showed normal spontaneous polarization. Crystals below the critical size have still an unexpected dielectric anomaly at $1{\cdot}0 \pm 0{\cdot}5$°C below the Curie temperature of the macroscopic crystal, suggesting an antiferroelectric transition. However, the superstructure lines, characteristic for antiferroelectricity, could not be detected either with X-ray or with electron diffraction. A.

537.226.2

8388. Concentration dependence of the dielectric constant of ionic solutions. M. MORIYAMA. Note in *J. Phys. Soc. Japan*, **8**, 423–4 (*May–June*, 1953).

Using the treatment proposed by Debye [*Polar Molecules* (1929), p. 109], a qualitative dielectric constant-concentration formula applicable to solutions of high concentration is derived.

G. I. W. LLEWELYN

537.226.2

8389. Some electrical properties of strontium titanate. A. LINZ, JR. Letter in *Phys. Rev.*, **91**, 753 (*Aug.* 1, 1953).

Activation energy is 0·68 eV and an absorption peak at 2 μ corresponds to this. Absorption edge 395 mμ corresponds to a forbidden energy gap $3{\cdot}1_5$ eV. Dielectric properties as functions of temperature and frequency are recorded. C. A. HOGAR

537.226.2 : 538.565 : 621.317.335.3 : 621.315.61

8390. Measurement of permittivity of mixed bariu and strontium titanate in 3000 Mc/s region. IWAYANAGI. *J. Phys. Soc. Japan*, **8**, 525–30 (*July–Au* 1953).

The permittivity was measured by observing t resonances of a sample inserted either in a water-fill cavity resonator or in a waveguide window. the two methods the temperature dependence (Ba : 80%, Sr : 20%)TiO_3, its frequency dependen in a region between 2200 Mc/s and 3500 Mc/s, and t permittivities for several constitutions of barium a strontium, were measured. The results indicate t existence of a dispersion in this frequency region.

537.226.2 : 548

Note on the relations between phase transitio lattice defects, and Debye phenomena in solids. *Abstr.* 8774

537.22

8391. Dielectric relaxation processes in ethan F. X. HASSION AND R. H. COLE. Letter in *Natu* [*London*] **172**, 212–13 (*Aug.* 1, 1953).

Experimental evidence for a second, high-frequen (~1 kc/s) dielectric relaxation region for supercool $C_2H_5OH + 1\%\ H_2O$ below −147°C. D. H. WHIFF

537.226.8 : 536.4

8392. The dielectric properties of barium titana single crystals in the region of their upper transiti temperature. L. E. CROSS. *Phil. Mag.*, **44**, 1161– (*Oct.*, 1953).

Measurements have been made of the ferroelectr hysteresis and dielectric constant of small sing crystals of barium titanate from 20°C to 150°C. untwinned crystals, free from external constraint, t results clearly indicate that the ferroelectric transiti occurring in the region of 120°C is a thermodynamica first-order transition. Over a small range of te perature above the zero field transition electr hysteresis is reintroduced by the application of sufficient electric field. The forms of the hystere figures in this temperature range are qualitative explained in terms of Devonshire's treatment of t ferroelectric effects. In twinned crystals, optical a electrical measurements show that it is not possib to fix accurately a transition temperature for the who specimen, as different regions transform at differe temperature. It is suggested that the behaviour these specimens may be due to imperfections in t crystal lattice, which give rise to local stresses in t region of the transition.

537.228.1 : 548

8393. Technique for testing the piezoelectric pr perties of crystals. Y. IITAKA. *Acta cryst.*, **6**, 663 (*July*, 1953).

A periodic pressure is applied to the piezoelectr crystal by a small vibrator driven by a 1000 c oscillator and the output from the crystal is amplifi and displayed on an oscilloscope. The method c

e used for examining tiny fragments of crystal and r detecting feeble piezoelectricity. Harmotone, $Ba_2Si_{12}Al_4O_{32} \cdot 12H_2O$, was found to be slightly iezoelectric. H. J. H. STARKS

LECTRIC CONDUCTION . CURRENTS 537.3

537.311.1 : 535.34

8394. Resistance-independent absorption of light aves by metals, and the properties of ideal conductors. , LINDHARD. Letter in *Phil. Mag.*, **44**, 916–19 *Aug.*, 1953).

A qualitative discussion of the modifications introuced into the theory of the optical properties of etals when the velocities of the free electrons and he finite extension in space of the electromagnetic eld are taken into account. E. H. SONDHEIMER

537.311.1 : 535.393

8395. On the interpretation of the optical constants f the alkali metals. H. SCHOPPER. *Z. Phys.*, **135**, No. 2, 163–7 (1953) *In German.*

An improved evaluation of the experimental results of Ives and Briggs (1936, 1937) on the basis of the heory of Kronig (1931). Values are tabulated of the number of free electrons per atom and of the time of elaxation in Na, K, Rb, Cs. E. H. SONDHEIMER

537.311.22 : 536.631 : 548.736.3

Thermal and electrical properties and crystal structure of tungsten oxide as high temperatures. *See Abstr.* 3796

537.311.31

8396. The electrical resistivity of liquid iron. R. W. POWELL. *Phil. Mag.*, **44**, 772–5 (*July*, 1953).

As a result of some preliminary experiments, which are described, the electrical resistivity of iron just above its melting point has been found to be 139 $\mu\Omega$ cm^2/cm. The resistivity of solid iron has also been measured and a value of 127 $\mu\Omega$ cm^2/cm is indicated at the melting point. Thus the increase in resistivity on fusion is only 9%, which is much less than would be expected on theoretical grounds and has been obtained for most other metals. A.

537.311.32

8397. Photocurrent, space-charge buildup, and field emission in alkali halide crystals. A. VON HIPPEL, E. P. GROSS, J. G. JELATIS AND M. GELLER. *Phys. Rev.*, **91**, 568–79 (*Aug.* 1, 1953).

Additively coloured alkali halide crystals represent, in a first approximation, a transparent solid with frozen-in electrons which can be mobilized by light absorption. When moving towards the anode, these electrons leave a positive space charge behind, and an adjustable cathode fall results which can be steepened until electrons are released by field emission. The steady-state and transient solutions for the charging and discharging cycle are calculated, the effects of light intensity, wavelength and field emission discussed, and KBr crystals investigated experimentally as function of time, voltage, light intensity and colour-centre density. Field emission has been produced with voltages as low as 1 V, and a field-emission photocell has been realized. A.

537.311.32 : 621.315.616.9

8398. Effect of temperature on the conductivity induced in insulators by X-rays. J. F. FOWLER AND F. T. FARMER. Letter in *Nature* [*London*] **171**, 1020–1 (*June* 6, 1953).

Measurements on polyethylene exposed to 200 kV X-rays show a linear relationship between log (conductivity) and (temp.)$^{-1}$. A similar relationship, but with different slope, is obtained for the material some days after irradiation. From the gradients the energy levels of the conduction bands are shown to be 0·42 and 1·5 eV respectively. F. T. FARMER

537.311.32 : 621.315.616.9

8399. Effect of temperature on the conductivity induced in insulators by X-rays. N. W. RAMSEY. Letter in *Nature* [*London*] **172**, 214 (*Aug.* 1, 1953).

Polyethylene irradiated six months previously shows a d.c. leakage conductivity much more sensitive to temperature than unirradiated material. Electron energy levels thus determined are 1·45 and 0·50 eV, respectively, and the evidence is that X-rays produce positive holes at deeper levels than the impurity conduction bands. F. T. FARMER

537.311.33

8400. Electron spin in semiconductors. E. A. GUGGENHEIM. Letter in *Proc. Phys. Soc.* [*London*] *A*, **66**, 121–2 (*Jan.*, 1952).

[See Abstr. 4092 (1953) to which this is an addition.] The derivation is made on the basis of approach B of Abstr. 8185 (1952) (the "direct" method) to demonstrate that it can, in fact, take account of electron spin more powerfully and concisely than approach A (the "thermodynamic" method), which is therefore not necessarily to be preferred.

537.311.33

8401. Semiconductor statistics. P. T. LANDSBERG. Letter in *Proc. Phys. Soc.* [*London*] *A*, **66**, 662–3 (*July*, 1953).

Points out a misunderstanding by Guggenheim (preceding abstract) of the author's paper. By "approach B" was meant the previous incomplete treatments (to which approach A was preferred), not all "direct" statistical-mechanical approaches. All valid treatments must be equivalent to approach A. C. A. HOGARTH

537.311.33

8402. The semiconducting properties of cuprous oxide. VI. The temperature dependence of electrical conductivity at temperatures between +20°C and −190°C. G. BLANKENBURG AND G. SCHUBART. *Ann. Phys.* [*Leipzig*] **12**, *No.* 4–6, 281–96 (1953) *In German.*

For Pt V, see Abstr. 6503 (1952). Various specimens of carefully tempered Cu_2O were examined. The position of the knee of the curves of log cond. *v.* $1/T$, the heat of solution of oxygen (activation energy) and the constant conductivity term σ_0 in the usual equation relating conductivity σ and temperature, all depended on the oxygen pressure during the previous heat treatment. C. A. HOGARTH

537.311.33

8403. The semiconducting properties of cuprous oxide. VII. The Hall effect below room temperature. H. Nieke. *Ann. Phys.* [*Leipzig*] **12,** *No.* 4–6, 297–308 (1953) *In German.*

Measurements of Hall constant R and electrical conductivity σ were carried out on Cu_2O specimens, prepared by tempering at 960°C and oxygen pressures from 30 to 10^{-3} atm. followed by rapid quenching, in the temperature range +50°C to −150°C. At 2 atm. (preparation pressure) R which was positive showed a maximum and σ a minimum. For these specimens the mobility product $R\sigma$ increased between −60 and −100°C more rapidly than for specimens prepared at other tempering pressures. C. A. HOGARTH

537.311.33

8404. *p-n* junction revealed by electrolytic etching. E. Billig and J. J. Dowd. Letter in *Nature* [*London*] **172,** 115 (*July* 18, 1953).

Etching in 10% KOH solution at 25°C can reveal a *p-n* junction, and in the case of an *n-p-n* structure, if the *n*-regions are connected in parallel, these will be etched anodically, leaving the *p*-region unaffected and visible. A current density of ~1 mA/mm^{-2} for about a minute is sufficient. C. A. HOGARTH

537.311.33

8405. Thermally induced acceptors in single crystal germanium. R. A. Logan. Letter in *Phys. Rev.*, **91,** 757 (*Aug.* 1, 1953).

Experiments on the heat treatment of Ge, prepared so as to be free of all traces of Cu, suggest that the process causing the *n*- to *p*-thermal conversion is some sort of impurity diffusion into the Ge, but that if a chemical impurity is responsible then Cu is not necessarily significant. C. A. HOGARTH

537.311.33

8406. Evaporation of copper from germanium. G. Finn. Letter in *Phys. Rev.*, **91,** 754 (*Aug.* 1, 1953).

Radioactive Cu was diffused into Ge of known properties which was then heat treated. The evaporated Cu was collected and measured and corresponded to the loss of acceptors. C. A. HOGARTH

537.311.33

8407. Oxygen-induced surface conductivity on germanium. E. N. Clarke. Letter in *Phys. Rev.*, **91,** 756 (*Aug.* 1, 1953).

Results of heat treatments of very thin Ge specimens in various ambient gases indicate that adsorption of oxygen can introduce surface acceptor levels.

C. A. HOGARTH

537.311.33

8408. On the modulation of electrical resistance of germanium by a standing acoustic wave of high frequency. G. Mayer. Letter in *J. Phys. Radium*, **14,** 492 (*July–Aug.–Sept.*, 1953) *In French.*

A thin crystal of 11·7 ohm cm Ge was held in a Ge/glass/Al/quartz wafer assembly and was ground so that successive experiments with crystals of different thickness could be made. The quartz crystal oscillated at 1·05 Mc/s, the thickness of the system permitted half-wave resonance, the pressure on the Ge crystal varied, the number of free charge carriers changed, and hence a variation of resistance was observed.

C. A. HOGARTH

537.311.

8409. Thermal acceptors in vacuum heat-treat germanium. S. Mayburg and L. Rotondi. Let in *Phys. Rev.*, **91,** 1015 (*Aug.* 15, 1953).

Several cycles of Joule heating of Ge single cryst to various temperatures near the melting-point ir closed high vacuum system, followed by a ra radiation cooling and appropriate electrical measu ments, suggest that the thermal acceptors observ are lattice vacancies and not impurity atoms.

C. A. HOGAR

537.311.

8410. Hall effect and conductivity of InSb sin crystals. M. Tanenbaum and J. P. Maita. Let in *Phys. Rev.*, **91,** 1009 (*Aug.* 15, 1953).

Measurements are reported for two very pu *p*- and one *n*-type samples. Intrinsic conduction observed above about 150–180°K. The mobility ra in the intrinsic range is 85. It is difficult to estima the energy gap ΔE with certainty since no data a available for the effective masses of free electrons a holes. For appropriate functions of the effect masses $\Delta E = 0{\cdot}18$ eV in agreement with the abso tion edge value. C. A. HOGAR

537.311.33 : 535.3

The change of the refractive index of semi-conducti film irradiated by intense light. *See Abstr.* 8308

537.311.33 : 537.

8411. The electrical conductivity and thermoelect power of magnesium oxide. R. Mansfield. Letter *Proc. Phys. Soc.* [*London*] *B*, **66,** 612–14 (*July*, 195

Measurements on sintered specimens indicate th MgO is a defect semiconductor with an excess oxygen. The thermal activation energy is abo 2·2 eV and the thermoelectric power is 1·1 0·1 mV/°C in the range 950°C to 1400°C.

C. A. HOGAR

537.311.33 : 537.3

8412. Electrical properties of chromium-oxid alumina catalysts. R. Chaplin, P. R. Chapman an R. H. Griffith. Letter in *Nature* [*London*] **172,** (*July* 11, 1953).

The catalyst (I), of 70% Cr_2O_3 and 30% Al_2O_3 w compressed into a thin disk, and both its conductiv k and its thermoelectric potential θ were measured a condenser method. The behaviour of k in O_2 a H_2 shows I to be an amphoteric semiconductor, a that of θ shows I to be an electron-excess semicc ductor. The Hall coefficient was also measured. is suggested that the method offers considera promise for examining mixed catalysts. S. J. GRE

537.311.33 : 621.3.011 : 621.315.

8413. Semiconductor circuit elements. J. S. Blak more, A. E. De Barr and J. B. Gunn. *Rep. Pro Phys.*, **16,** 160–215 (1953).

Recent advances in the theory of the conducti mechanism in semiconductors and semiconducto metal systems are reviewed, together with th properties and applications. Since the more importa advances relate to systems whose properties depe upon the simultaneous flow of electrons and hol discussion is limited mainly to those materials, su as silicon and germanium, in which this phenomen

observed. A brief account is given of the fundamental concepts of semiconductor theory after which ch bulk properties of semiconductors as conctivity, behaviour of minority carriers, magnetic ects, noise and optical effects are discussed. Modern eories of rectification and transistor action at metal-niconductor contacts and *p-n* junctions are then nsidered, and descriptions given of the mechanisms d properties of practical circuit elements such as ystal diodes and transistors. (Bibl. 105 ref.) A.

537.311.33 : 621.315.592.4

14. Electrical properties of titanium dioxide semiconductors. R. G. BRECKENRIDGE AND W. R. HOSLER. *Phys. Rev.*, **91**, 793–802 (*Aug.* 15, 1953).

Measurements have been made of the electrical sistivity and Hall coefficient of semiconducting tile both in the form of ceramics and single crystals om −190°C to +500°C. The samples were reduced pure hydrogen for various times and temperatures provide a range of resistivities, all corresponding rather large numbers of charge carriers. The ngle crystal samples were measured in different ientations to study the directional dependence of sistivity and mobility. From these measurements e variations of mobility and charge carrier concenation with temperature have been determined. The obility data can be satisfactorily described in terms f an electron scattering by the optical modes of ttice vibration predominant at high temperatures ombined with a scattering by ionized impurities redominant at low temperatures. The low values of he mobility in all samples indicate an anomalously rge effective electron mass. In the crystalline samples he mobility in the *c* direction is approximately twice s great as in the *a* direction. The data on the temerature dependence of the electron concentration ay be represented by a sum of two Boltzmann rms, indicating two types of donor centres. It is ggested that these centres may be oxygen ion acancies at which one or two electrons are trapped s Ti^{+3} ions. An energy level diagram is proposed hich explains many of the electrical and optical bservations on rutile semiconductors. A.

537.311.33 : 621.316.89 : 621.315.59

415. Nonlinear semiconductor resistors. F. A. CHWERTZ AND J. J. MAZENKO. *J. appl. Phys.*, **24**, 015–24 (*Aug.*, 1953).

A phenomenological theory for the nonlinear oltage-current characteristic curve displayed by a ranular aggregate of silicon carbide is presented. he theory, which should apply to granular semionductors other than silicon carbide, is based on a ery simple model of the aggregate and on the assumption that the essential resistance is located at the rain–grain contacts, the impedance of the bulk naterial being considered negligibly small. The urrent i is related to the voltage l' by the equation $= kAP^{n/m}d^{n-2}V^n/t^n$, where A is the cross-sectional rea of the aggregate, t the thickness, P the applied ressure and d the average particle diameter. The onstants k, n and m are structure-sensitive, that is, hey depend on the physical-chemical nature of the particles forming the aggregate. Factors influencing the alues of these constants include impurity concenration in the semiconductor, elastic constants and particle shape. The validity of this equation is supported by careful measurements made on granular aggregates of silicon carbide. A.

537.311.33

8416. Contribution to the knowledge of the working of point-contact transistors. R. THEDIECK. *Z. angew. Phys.*, **5**, *No.* 5, 165–6 (1953) *In German.*

By means of chemical etching the depth of *n-* to *p-* conversion region in front of the point of a formed W/Ge contact was found to be about 14 μ. The effective barrier thickness was shown to be about 2 μ. By means of etching, the *p–n* junction could be made to stand out and if two points about 50–60 μ apart were formed in the same way and the same direction, a sort of *p–n–p* assembly was formed. The characteristics of this device were similar to those of normal formed point-contact transistors. C. A. HOGARTH

537.311.33

8417. On the temperature dependence of contact noise. Y. INUISHI. Note in *J. Phys. Soc. Japan*, **8**, 128 (*Jan.–Feb.*, 1953).

Experimental results are given, showing that for CuO and Se rectifiers noise is independent of temperature at 10 kc/s, whereas noise in carbon resistors increases with increasing temperature. Reasons for this are suggested. M. R. HOPKINS

537.311.33

8418. The influence of mobility variation in high fields on the diffusion theory of rectifier barriers. R. E. BURGESS. Letter in *Proc. Phys. Soc.* [*London*] *B*, **66**, 430–1 (*May*, 1953).

Shockley has shown that for high fields the electron drift velocity is no longer directly proportional to the electric field. Taking this into account in the diffusion equation, the theoretical *V–I* characteristic has the form obtained for a Mott barrier, but does not involve any assumption about the distribution of ions in the barrier region. C. A. HOGARTH

537.311.33

8419. Comparison, for an imperfect contact between two metals, of the conductivity resulting from tunnel effect and from thermal excitation of electrons over the potential barrier. N. NIFONTOFF. *C.R. Acad. Sci.* [*Paris*] **237**, 24–6 (*July* 6, 1953) *In French.*

Curves are given and illustrate which effect is preponderant for different barrier thicknesses.

C. A. HOGARTH

537.311.33

8420. Theory of the flicker effect. T. B. TOMLINSON AND W. L. PRICE. Letter in *J. appl. Phys.*, **24**, 1063–5 (*Aug.*, 1953).

Macfarlane's second theory of flicker noise from semiconducting surfaces [Abstr. 314 (1951)] based on a partial layer of neg. ions is applied to the retarding field diode. This leads to a result in which the noise current falls off more rapidly than the square of the mean anode current, which is contrary to experiment. A. H. W. BECK

537.311.33

8421. Effect of transit time on Ge rectifier behavior. R. BRAY AND B. R. GOSSICK. Letter in *Phys. Rev.*, **91**, 1011 (*Aug.* 15, 1953).

The effect of transit time on frequency characteristics of Ge rectifiers was studied using very fast pulse

techniques. The forward current-voltage characteristic of a point contact rectifier was measured using a 0·4 μsec pulse. The resistance is shown to be larger at the beginning of the pulse than at the end, where the characteristic is the same as for d.c., indicating that transit times of less than 0·4 μsec are involved. In *p–n* junction rectifiers the resistance changes more slowly, little change being found during a 3·6 μsec pulse. If the junction is cooled to 80°K, then pulse and d.c. measurements are indistinguishable, suggesting very short lifetimes at this temperature. D. G. AVERY

537.311.33

8422. Post-injection barrier e.m.f. of *p–n* junctions. B. W. GOSSICK. Letter in *Phys. Rev.*, **91**, 1012 (*Aug.* 15, 1953).

When a rectifier passes forward current and then a reverse voltage is applied a large transient reverse current flows because of an e.m.f. developed by the barrier due to non-equilibrium barrier conditions. The barrier e.m.f. is measured by injecting carriers across a *p–n* junction with a crystal diode in series, thereby simulating approximately open-circuit conditions. C. A. HOGARTH

537.311.33 : 621.314.634

8423. Direct current characteristics of the selenium rectifier. I. Theory of rectification. M. TOMONO. *J. Phys. Soc. Japan*, **8**, 477–83 (*July–Aug.*, 1953).

On the assumption that the barrier layer of the selenium rectifier has a construction composed of *n*-type semiconductor, insulating film and *p*-type semiconductor, the author offers a new rectification theory. The direction of rectification due to the insulating film is not inverse to that found experimentally, as in Wilson's theory. A.

537.312.5

8424. Infra-red photo-conductors. R. A. SMITH. *Advances in Phys.*, **2**, 321–69 (*July*, 1953).

Reviews research carried out mainly since 1947 on the properties of infrared photoconductors as semiconductors, and gives an account of infrared cell development during the same period. Contains a certain amount of information not yet published elsewhere. The review is mainly concerned with the PbS group of semiconductors (PbS, PbTe, PbSe); measurements of resistance, Hall constant, infrared absorption, photoconductivity and thermoelectric power, both for polycrystalline forms (evaporated and chemically deposited layers and bulk samples) and for single crystals, are discussed in detail, and the results compared. The method of preparing single crystals is outlined, and photovoltaic effects, rectification and transistor action and other properties are also discussed. Reference to other infrared photoconductors follows, and a comparison is made between the PbS group and Ge and Si. The theory of photo effects in the PbS group is then considered. In this section the influence of radiation on intercrystalline barriers, the source of primary photoelectrons and the relationship between the long wave limit of photoconductivity and the dielectric constant are discussed, and the results of a theoretical evaluation of the band structure of PbS outlined. Details are given of the sensitivity of response and the minimum energy which is detectable by typical PbS, PbTe and PbSe cells, and the theoretical ultimate limit of the sensitivity of such a cell discussed. 87 references. J. DUTTO

537.312

8425. Surface photoconductivity in cadmium sulphide crystals. R. H. BUBE. Letter in *J. chem. Phys.*, **21**, 1409–10 (*Aug.*, 1953).

It is shown that in presence of water vapour the photosensitivity and time constant of CdS excited by radiation of wavelength below that of the absorption edge decreases but for longer wavelength excitation remains unaffected. Theoretical discussion of the effect is given. G. F. J. GARLICK

537.312.6

8426. Thermal resistivity of superconducting mercury in the intermediate state. R. T. WEBBER AND D. A. SPOHR. *Phys. Rev.*, **91**, 414 (*July* 15, 1953).

At low temperatures the thermal resistance of H cylinders in the intermediate state as a function of the applied transverse magnetic field shows a sharp maximum (as found earlier for Pb, Sn, In). The form of this maximum was almost identical for cylinders of diameter 0·1 in. and 0·2 in. and it is inferred that the extra thermal resistance is due to scattering of electrons by laminar boundaries, it is the fine rather than the coarse structure of the intermediate state which is relevant (since the coarse structure should be on a scale which varies with specimen diameter). D. SHOENBERG

537.32 : 536.53

Tellurium/metal couples as fast thermoelements. *See Abstr.* 8381–2

ELECTRIC DISCHARGES 537.52

537.52 : 621.3.014.31 : 621.3.015

8427. Electrical discharges. F. LLEWELLYN JONES. *Rep. Progr. Phys.*, **16**, 216–65 (1953).

Recent developments in electrical discharges are surveyed under the main headings: the breakdown of gases in static fields; high-frequency discharges; cold emission phenomena; and the regime of space charges. Investigations of the fundamental processes of electrical breakdown at high and low pressures for long and short gaps by measurements of the growth of ionization current just prior to breakdown are described; a generalized view is made possible regarding breakdown as a consequence of the development of pre-breakdown ionization currents by primary and secondary processes which are themselves controlled by the nature and geometry of the cathode. Properties of *E* and *H* h.f. discharges are outlined, and a general theory of h.f. breakdown and of maintained discharges is given. It is shown how further knowledge of the behaviour of ionized gases is obtained which has led to a greater understanding of collision processes such as attachment and recombination. Various applications are indicated. Studies of the important role played by surface films in the cold extraction of electrons from electrodes are described

d applications of the results to arc discharges, high-oltage high-pressure breakdown, and cathode phenoena in breakdown are indicated. Work on the ture of r.f. plasma oscillations, and the generation noise by discharges, is described. An account of cent work on arc discharges is given, dealing parcularly with cathode phenomena and the thermal d optical properties of the arc column. 214 ferences. A.

537.523 : 538.67

428. The generation of magnetic fields in rotating asmas. W. LOCHTE-HOLTGREVEN AND P. SCHILLING. etter in *Naturwissenschaften*, **40**, *No.* 14, 387 (1953) German.

Describes an experimental arrangement whereby e hypothesis that electric currents and therefore agnetic fields may be generated in rotating plasmas Abstr. 5072, 7694 (1950); 5430 (1951)] is verified. he magnetic field observed, under given conditions velocity and acceleration, is about 10^{-4} oersted, in greement with theory. E. P. WOHLFARTH

537.523 : 538.67

429. The generation of magnetic fields in circulating quid mercury. F. BURHORN, H. GRIEM AND W. OCHTE-HOLTGREVEN. Letter in *Naturwissenschaften*, 0, *No.* 14, 387–8 (1953) *In German.*

See preceding abstract. Describes an experiment sing a rotating tube filled with mercury. The results re in qualitative agreement with theory, which is ightly amended to take account of changes of the nic velocity. E. P. WOHLFARTH

537.523.4

430. On the formation of gaseous discharges. H. RAETHER. *Z. angew. Phys.*, **5**, *No.* 6, 211–17 (1953) *In German.*

A discussion of the mechanisms of spark formation, ith special reference to the formative time data of änger and Fisher and Bederson. The author ggests that the conditions of these expts. refer to n intermediate region lying between the arbitrary d. (pressure × gap length, uniform field conditions) alues of ~10 and ~1000 mm × cm. For higher alues than the latter the author contends that the reamer mechanism applies. Formative times are alculated for various overvoltages, in reasonable greement with measured values. J. D. CRAGGS

537.523.5

431. Spectral radiant intensity and temperature f the high intensity alternating carbon arc. D. T. J. ER HORST AND G. A. W. RUTGERS. *Physica*, **19**, 65–84 (*July*, 1953).

The absolute spectral radiant intensity was easured in wavelength region from 260 to 600 mμ. he radiant intensity increases linearly with current nd pressure and decreases, for a given current and ressure, with the square of the wavelength. For a urrent of 1000 A and a pressure of 2 atmos, the adiant intensity amounts to 1 W/ster mμ per cm arc ngth at 450 mμ. The temperature in the axis of the rc, derived from the intensity of the continuous pectrum with the aid of Unsöld's theory, is nearly 6 000°K at current maximum and 10 000°K near urrent zero. A.

537.525

8432. Microwave technique for studying discharges in gases. M. A. LAMPERT AND A. D. WHITE. *Elect. Commun.*, **30**, 124–8 (*June*, 1953).

The effect of subjecting localized regions (~1 mm long) of a glow discharge in neon to pulses of microwaves was investigated by measuring the changes produced in the discharge current. A region near the cathode, which is thought to coincide with the region of reverse field known to exist near the cathode of a glow discharge, was found to be most sensitive to the microwave signal. J. DUTTON

537.525.3 : 537.525.72 : 537.525.8

8433. The effect of "ageing" on the positive and negative Joshi effects in the region of self-sustained and non-self-sustained a.c. discharges. N. SUBRAHMANYAM AND N. A. RAMAIAH. *Z. Phys.*, **135**, *No.* 3, 274–82 (1953) *In German.*

Describes studies of the a.c. electrodeless corona discharge in iodine vapour. The sign and magnitude of the Joshi effect (change of discharge current due to external irradiation) as a function of discharge voltage are plotted. Ageing phenomena are discussed in terms of adsorbed layers formed in the tube. J. D. CRAGGS

537.525.4

8434. Breakdown of a gas subject to crossed electric fields. W. A. PROWSE AND P. E. LANE. Letter in *Nature* [*London*] **172**, 116–17 (*July* 18, 1953).

Describes experiments in air, H_2 and Ne using auxiliary fields to test hypothesis that to-and-fro drift motion of electrons helps discharge-initiation at microwave frequencies [see Abstr. 2727 (1952)]. Unidirectional fields caused an increase in breakdown stress under repeated 1 μsec, 10^4 Mc/s pulses. An alternating field (1·3 and 10 Mc/s) apparently acts independently of the microwave field and does not help breakdown. C. G. MORGAN

537.525.8

8435. Further determinations of the energy distribution of electrons in the positive columns of gas discharges. C. HAIGH AND R. K. MCCULLOCH. *Proc. Leeds Phil. Lit. Soc.*, **6**, 82–9 (*Dec.*, 1952).

Describes probe measurements in hot-cathode glow discharges in air, argon and nitrogen at pressures varying from 0·005 to 0·085 mm Hg, 15–35 mA tube current at a tube voltage of 600 V. Maxwellian distributions were found in certain cases, e.g. at the highest argon pressure (0·0825 mm Hg) but the distributions were often strongly non-Maxwellian and sometimes showed pronounced double peaks. These effects are discussed in terms of the finite number of inter-electrode electron collisions, Ramsauer cross-sections, etc. J. D. CRAGGS

537.525.8

8436. The energy spectrum of canal ray ions. K. DEUTSCHER AND D. KAMBE. *Z. Phys.*, **135**, *No.* 4, 380–94 (1953) *In German.*

Describes experiments on the determination of the structure of the ion pencil in high-voltage low-pressure canal ray glow discharge tubes. The gases used included H_2, O_2, He and A at ~10–30 kV and a few milliamps current, at pressures ~10^{-2} mm Hg. Energy spectra are given with some theoretical discussion of the results. J. D. CRAGGS

537.525.8

8437. Dependence of glow to arc transitions on cathode surface conditions. H. EDELS. Letter in *Nature* [*London*] **172,** 362–3 (*Aug.* 22, 1953).

Gives results of experiments in which a glow discharge was moved electromagnetically between parallel W and Cu rod electrodes, to determine whether glow-to-arc transitions occurred at localized cathode spots which had been specially treated (by deposition of salt or salt solutions or by local oxidation). J. DUTTON

537.529 : 548.0

8438. Directional dielectric breakdown in single crystals. T. SUITA. Note in *J. Phys. Soc. Japan,* **8,** 126–8 (*Jan.–Feb.*, 1953).

Experiments on NaCl and KCl at room temperature and at 150°C using both d.c. and impulse fields are reported. At low temperatures the "high-energy criterion" of von Hippel applies but at high temperatures the "low-energy criterion" of Fröhlich seems more appropriate. C. A. HOGARTH

537.529 : 548.7

8439. A note on the theory of the electron multiplication in insulating crystals. H. KAWAMURA. Note in *J. Phys. Soc. Japan,* **8,** 424–5 (*May–June*, 1953).

Derives an expression for the mean range of an electron before causing ionization which is similar to that previously obtained by Seitz. C. G. MORGAN

X-RAYS 537.531

537.531 : 535.43

8440. The incoherent scattering of X-rays. F. LENZ. *Z. Phys.*, **135,** *No.* 2, 248–50 (1953) *In German.*

Mathematical. Suggests an improvement to the scattering factor in the Heisenberg and Bewilogua expression for the intensity of incoherent scattering of X-rays. This is effected by the use of the Molière approximation for the Thomas–Fermi function. J. THEWLIS

537.531.08 : 537.542

8441. The röntgen: deficiencies in present-day free-air chamber standards. L. A. W. KEMP. Letter in *Nature* [*London*] **172,** 35 (*July* 4, 1953).

Experiments with pressurized free-air ionization chambers and also with a model of the N.P.L. standard parallel-plate chamber, have shown that errors introduced by inadequate lateral geometry in the present free-air standard chambers vary with the energy of the X-rays measured. For 200 kV X-rays, errors exceed 2% for the British and are likely to be 1·5% for the U.S. standard. An account of the experiments will be published later. D. V. MABBS

CATHODE RAYS . POSITIVE RAYS 537.533/.534

537.533 : 535.215.2

8442. Kramer and Russell effects with single crystals of zinc. L. GRUNBERG AND K. H. R. WRIGHT. Letter in *Nature* [*London*] **171,** 890–1 (*May* 16, 1953).

Single crystals of zinc were cleaved on the 0001 plane. Cut-off wavelength for photoelectric respon increased to 5000 Å by abrasion of cleavage surfa compared with 3000 Å for the undisturbed surfa indicating the formation of areas of low work functi by abrasion (Kramer effect). Darkening of a phot graphic plate placed in contact (Russell effect), w much greater for the abraded than for the undisturb surface. [Captions to photographs illustrati Russell effect are reversed.] J. W. MENT

537.533 : 548.7 : 535.3

Field emission of crystal phosphors. *See Abstr.* 83

537.533.72 : 537.534.

8443. Double focusing of charged particles by system of two magnets with nonuniform fields. R. STERNHEIMER. *Rev. sci. Instrum.*, **24,** 573–85 (*Au* 1953).

Equations are obtained for the focusing by a syst of two magnets with nonuniform fields such th $n > 0$ in the first magnet and $n < 0$ in the secon For each magnet a lens equation is set up, and th the system of the two magnets is itself treated as thick lens. It is shown that for very large n, there in general one object distance for which doub focusing takes place. The theory is also applied deflecting systems with moderate values of n, and is shown that the entrance and exit angles can reduced to values of the order of 20° even for sm deflections (20°) of the charged particle.

537.533.72 : 621.385.8

8444. An industrial model of the EM-4 electron graph. G. O. BAGDYK'YANTS. *Izv. Akad. Na SSSR, Ser. Fiz.*, **17,** *No.* 2, 255–64 (1953) *In Russia*

Developed from the experimental model describ in *Zav. Lab.*, **12,** 1445 (1950), the mass-producti version has been redesigned, particularly as regar its lens system. Working with a maximum h voltage of 45 kV the instrument has two magne lenses and when used for electron diffraction has accuracy of 0·003 Å for planes of 1 Å spacing. Wh used as an electron microscope the resolution is abo 500 Å with a useful magnification of 4000. The bea current is 10–15 μA. The instrument can also used as a micro-source of X-rays for radiography. A. L. MACK

537.533.72 : 621.385.8

8445. Construction of a universal electron diffracti microscope and its optical features. K. TANAKA A H. HASHIMOTO. *Rev. sci. Instrum.*, **24,** 669–75 (*Au* 1953).

Consists of three-stage electron lens and tw specimen chambers and functions both as an electr microscope and as an electron diffraction unit. Th instrument can be used in the following way (1) Electron microscope; range of magnificati between 800 and 20 000 times can be covered co tinuously. (2) Electron microdiffraction unit; electr diffraction pattern characteristic of any small area a specimen under microscopic observation can revealed by a switch. (3) Dark-field electron micr scopic image. (4) High-resolution electron diffracti unit. (5) Effective camera length of electron diffra tion is variable from 0 to 250 cm. (6) Shadd micrographs of the specimen used in (4) can directly obtained. (7) Shadow microdiffracti (probe diffraction); dark-field microscopic ima

ppears in each diffraction spot. The specimen in he second chamber can be heated at any temperature p to about 800°c; two kinds of substances can be vaporated on to it, and the evaporation gun can so be used for charge neutralization. A.

537.533.74

8446. Electron-electron scattering in the energy egion from 200 to 300 keV. K. Ulmer. *Z. Phys.*, **35**, *No.* 2, 232–47 (1953) *In German.*

Incident electrons are scattered by electrons which re only slightly bound (in hydrogen) and which can e considered as free at these incident energies. The cattered and recoil electrons are detected in coincidence, thus separating this process from scattering y the proton. The results are in agreement with the Møller formula. G. E. BROWN

537.533.74

8447. Further measurements of the single scattering f electrons by nuclei. E. Kinzinger. *Z. Naturforsch.*, **a**, 312–15 (*May*, 1953) *In German.*

Refined experiments on the lines of Abstr. 8893 1952) confirm that in the range 150–400 keV the bserved cross-section falls below Mott's theoretical alue with increasing Z and θ. No interference effects re present in the angular distribution, showing that he atomic electrons cannot be responsible [cf. Mohr, bstr. 400 (1944)]. W. J. Swiatecki

537.533.74

8448. Elastic scattering of electrons. L. R. B. lton. *Proc. Phys. Soc.* [*London*] *A*, **66**, 806–12 *Sept.*, 1953).

It is shown that, to a high degree of accuracy, the cattering of fast electrons by atomic nuclei is ndependent of the model chosen for the charge tructure of the nucleus, even if the energy of the lectrons is sufficiently high for several of the partial cattered waves to be modified by the finite extent of he nucleus. A.

537.533.74 : 539.152.1

8449. Investigation of nuclear motion by electron iffraction. L. S. Bartell and L. O. Brockway. Letter in *Nature* [*London*] **171**, 978–9 (*May* 30, 1953).

Follows on the work of Schomaker and Glauber Abstr. 8891 (1952)] on the effect of the variation with cattering angle of the phase shift of electron waves cattered by atoms, and points out that such phase hifts must be taken into account in the calculation of ibrational amplitudes, even for light atoms. Examples are quoted. J. Thewlis

537.533.8

8450. Method of measuring the induced conductivity nd secondary emission of insulators under electronic ombardment. C. Dufour, A. Herpin, J. P. Thomas and G. Wendt. Letter in *J. Phys. Radium*, **14**, 429–30 (*June*, 1953) *In French.*

A new method involving a rotating cylinder covered with a film of insulator, and revolving between wo diametrically opposite electron guns, is described. C. A. Hogarth

537.533.8 : 537.534.8

8451. Ionization at relativistic energies and polarization effects. M. Huybrechts and M. Schönberg. *Nuovo Cimento*, **9**, 764–807 (*Sept.*, 1952).

A theory of the polarization effects in the energy loss of a charged particle is given, in which the mechanism of the loss is different from that of the Fermi theory. This theory leads to a distribution of the loss between ionization-excitation and emission of Cherenkov radiation which differs considerably from that of the theories on Fermi's lines, although the stopping power is not essentially changed, being somewhat less than in those theories. This treatment leads to an increase of the direct ionization at impact parameters larger than atomic dimensions after the relativistic minimum, the increase being large in the case of gases. The Fermi saturation effect of the loss at distances larger than atomic dimensions does also exist in the present theory, although due to a different mechanism. The relativistic increase of the loss in distant interactions is due largely to an increase of the radii of action for ionization and excitation (Bohr–Williams mechanism), but there is also a contribution of the Cherenkov radiation (Fermi mechanism). The saturation arises from a limitation of the increase of the radii of action due to the polarization of the medium and to the saturation of the emission of Cherenkov radiation. This theory leads to a modification of the formula of Frank and Tamm for the rate of emission of Cherenkov radiation, the emission of high-energy Cherenkov radiation being considerably reduced. A.

537.533.9

8452. Bombardment of ordered Cu_3Au by 1 MeV electrons. C. E. Dixon, C. J. Meechan and J. A. Brinkman. Letter in *Phil. Mag.*, **44**, 449–50 (*April*, 1953).

Bombardment of Cu_3Au with $3{\cdot}4\times10^{19}$ electrons per cm^2 of energy 1 MeV at temperatures $< -185°c$ produced no appreciable change in resistivity (which $= 1{\cdot}52$ μohm. cm at $-195°c$). It is concluded that the interstitial-vacancy pairs formed largely recombined at the irradiation temperatures, probably without requiring thermal activation. J. Franks

537.534 : 538.561 : 621.384.612: 621.396.615 : 621.316.5.064

8453. Oscillator switching for variable frequency synchrotron control. D. E. Caro and L. U. Hibbard. *Phil. Mag.*, **44**, 964–70 (*Sept.*, 1953).

A method is discussed for switching from one sweeping oscillator to another or to a fixed oscillator, without significant discontinuity of frequency, phase or amplitude. The particle acceleration frequency in the Birmingham proton synchrotron is derived from a mechanically tuned beat oscillator [Abstr. 1770 (1953)]. A circuit based on the above method is described, by means of which the output frequency is locked at a specified value when reached by the sweeping oscillator. A.

537.534 : 539.164

The interaction between the α-particles and the protons inside the molecule $Bi^{212}H_3$. *See Abstr.* 8656

537.534 : 621.319.523 : 621.316.722

8454. A regulator for a 20 to 250 kilovolt Cockcroft–Walton accelerator. C. J. Cook and W. A. Barrett. *Rev. sci. Instrum.*, **24**, 638–40 (*Aug.*, 1953).

A regulator has been built to hold the accelerating potential of a Cockcroft–Walton accelerator to

within 0·015% of any pre-set potential in the range of 20–250 kV. The regulator is a degenerative type where the error signal is amplified by a galvanometer-phototube-d.c. amplifier system which controls a variable impedance transformer in series with the high-voltage power transformer primary. The regulator is very simple to put into operation. Its action is independent of the potential desired; therefore the range of operation could easily be extended. A.

537.534 : 621.384.611

8455. The theory of the fixed frequency cyclotron. B. L. COHEN. *Rev. sci. Instrum.*, **24**, 589–601 (*Aug.*, 1953).

The theory of the fixed frequency cyclotron is developed and illustrated at each step with numerical results for an example. The conditions for ion transmission with respect to horizontal motion are derived, and it is shown that they are satisfied by all ions in most cyclotrons. A more correct and more complete focusing formula than that found in the literature is derived and used to integrate the vertical motion. It is characterized by a region in which the net force is defocusing causing the ions to diverge exponentially from the median plane. The theory is applied to find the maximum energy attainable as a function of dee voltage and magnetic field fall-off. The problem of orbital precession is treated quite generally, and equations for calculating the centre of curvature as a function of time are derived. Some considerations in the magnetic field design are presented. A proof is given that ions experience strong radial grouping. The effect of ion source "feelers" is discussed. A.

537.534 : 621.384.612

8456. Stability of orbits in a strong-focusing synchrotron. S. LUNDQUIST. *Phys. Rev.*, **91**, 981–3 (*Aug.* 15, 1953).

The influence of gaps for injection, acceleration, etc., on the stability of orbits in a strong-focusing synchrotron is examined and found not to be negligible. The calculation also gives some information about the resonances resulting from irregularities. A.

537.534.72

8457. A pulsed mass spectrometer with time dispersion. M. M. WOLFF AND W. E. STEPHENS. *Rev. sci. Instrum.*, **24**, 616–17 (*Aug.*, 1953).

An improved design of a pulsed mass spectrometer using linear time of flight analysis has been completed. A peak width of two mass units at mass 40 has been achieved as well as a linear mass scale. A.

537.534.72 : 513.76

8458. Realization of special contact transformations with static electromagnetic fields *in vacuo*. G. IWATA. *Progr. theor. Phys.*, **8**, 183–92 (*Aug.*, 1952).

Particle-focusing systems perform contact transformations of some specified characters between initial and final variables. The problem is here approached from the mathematical end. Necessary conditions for two contact transformations (i.e. coordinate-coordinate transformation and momentum-coordinate transformation), are obtained with static electromagnetic fields *in vacuo*. A velocity-coordinate transformation is shown to be impossible. A example of electromagnetic field allowing the tw contact transformations is given.

537.534.

8459. The relative stopping power of hydrogen a of helium for slow α-particles. P. N. COOPER, V. CROCKER AND J. WALKER. Letter in *Proc. Phys. So* [*London*] *A*, **66**, 658–9 (*July*, 1953).

Cloud chamber measurements are reporte showing that earlier data indicate too great a variati in stopping power with α-particle velocity.

J. J. WILKI

537.534.

8460. Range-energy data from the $^{10}B(n,\alpha)^7Li$ a $^6Li(n,t)^4He$ reactions. P. N. COOPER, V. S. CROCK AND J. WALKER. Letter in *Proc. Phys. Soc.* [*Londo A*, **66**, 660–1 (*July*, 1953).

Cloud chamber measurements indicate air-ranges $0·725 \pm 0·007$ cm and $5·97 \pm 0·05$ cm for boron α-particles and lithium tritons respectively.

J. J. WILK

DISCHARGE TUBES . COUNTERS 537.54

537

8461. Physics in the electronic valve indust J. THOMSON. *Brit. J. appl. Phys.*, **4**, 262–7 (*Sep* 1953).

Shows the importance of physics in the developm and production of thermionic valves, cathode-r and flash tubes, photocells, transistors, crystal dio and similar devices; some examples of this work cited.

537.

8462. The effect of small a.c. voltages on the c charge current in gas-filled grid-controlled electr tubes. A. SZÉKELY. *Acta. phys. Austriaca.*, **7**, *No* 164–80 (1953) *In German.*

An exhaustive account of the characteristics of gas filled triode 4690 (made by Philips) when sm a.c. signals are superimposed. The characteris plotted include anode current-anode voltage (d curves, striking characteristics with a.c. of vari frequencies superimposed in varying amounts, curves showing the effect of frequency of the ($\sim 10^6$ c/s). Some discussion of the results is given

J. D. CRA

537.

8463. A high-intensity pulsed ion source. J. GOW AND J. S. FOSTER, JR. *Rev. sci. Instrum.*, 606–10 (*Aug.*, 1953).

A pulsed cold cathode ion source, giving peak p ton currents in excess of one milliampere and aver currents up to 50 microamperes, is described. source is based on the Penning discharge using a extraction of the ions. Some discussion of the charge mechanism and the role of the cathode mate is included. Installation and operation of this sou in the Berkeley 4-MV Van de Graaff and its formance in that machine is discussed.

537.542

8464. Design and performance of a radio-frequency ion source. L. K. GOODWIN. *Rev. sci. Instrum.*, **24**, 35–8 (*Aug.*, 1953).

Tests were made on a 27 Mc/s, inductively coupled, r.f. ion source standardized in design for use at the Los Alamos Scientific Laboratory. Total deuteron beam current and probe current characteristics were found, in tests made before installation, as a function of gas pressure of the discharge, r.f. power input, probe voltage, and extraction system geometry to determine the best values of these variables to use. These characteristics showed a maximum total beam current of 600 μA to be obtained with roughly 200 watts of r.f. power input. Tests made after installation in an accelerator gave 92% monatomic deuteron beams of up to 80% the strength found under similar conditions in the tests made before installation. A platinum coated envelope gave a triatomic beam of about one-eighth the strength of the monatomic beam obtained with an uncoated envelope. The source has been used at 150 lb/in.^{2} external pressure in a Van de Graaff tank. A.

537.542 : 537.534.72

8465. A mass spectrometer ion source for solid material. G. H. PALMER AND K. L. AITKEN. *J. sci. Instrum.*, **30**, 314–16 (*Sept.*, 1953).

A source is described where the material under analysis is normally in a solid form of very low vapour pressure at room temperature. Well collimated, monoenergetic ion beams of the order of 10^{-11}–10^{-12} A are obtainable, which makes the source suitable for use in a single focusing instrument of 6 in. radius of curvature. Some typical analyses are given of lead and uranium. A.

537.542

8466. The mechanism of counter tube discharges in argon. L. COLLI AND U. FACCHINI. *Nuovo Cimento*, **9**, 1183–217 (*Dec.*, 1952) *In Italian.*

A very comprehensive paper, illustrated with many oscillograms, dealing with the mechanism of build-up of a Geiger counter discharge in A and A–CO_2 for pressures ranging from 150 to 1000 mm Hg. The pulse shapes show that the initial avalanche is amplified by means of photo-emission of electrons at the cathode. The excited levels in A, which could be operative, are discussed. The effects of addition of CO_2 are explicable by consideration of collisions of the second kind between CO_2 molecules and excited A atoms. At higher concentrations ($> 5\times10^{-3}$) of CO_2 a secondary process of electron production in the gas is postulated. Some discussion of Hg vapour–A discharges is also given. J. D. CRAGGS

537.542

8467. On energy resolution with proportional counters. G. S. HURST AND R. H. RITCHIE. *Rev. sci. Instrum.*, **24**, 664–8 (*Aug.*, 1953).

The shape of a proportional counter pulse due to an extended track of ionization is determined, before and after passing through a linear pulse amplifier, for various values of track extension and positive ion collection time. It is found that the maximum height of the amplifier output pulse is essentially independent of the length and orientation of the track in the counter, provided the time of collection of the outermost electrons is not longer than the amplifier time constant. A.

537.542 : 621.387.42

8468. Recent developments in the production of halogen-quenched Geiger-Müller counting tubes. L. B. CLARK, SR. *Rev. sci. Instrum.*, **24**, 641–3 (*Aug.*, 1953).

Geiger–Müller tubes have been constructed which use visibly transparent nonmetallic electrically conducting films as cathodes. These tubes have the following advantages: (1) a long plateau; (2) no photosensitivity; (3) an almost indefinite operating life; (4) immunity from damage arising from heavy discharges; (5) straightforward filling procedure devoid of any "passivising" or saturating techniques; (6) good response to ionizing radiation throughout the length of the counter; (7) freedom from use of critical materials such as copper or stainless steel No. 446 which require special cleaning and polishing procedures. A.

537.542

8469. Effect of space charge on saturation properties of ionization chambers. A. C. LAPSLEY. *Rev. sci. Instrum.*, **24**, 602–5 (*Aug.*, 1953).

Experiments on cylindrical ionization chambers operating at high-current densities showed that more voltage was required to produce saturation when the central electrode was negative than when it was positive with respect to the outer cylinder. An analysis is made which indicates this phenomenon might be explained by the positive ion space charge. Under the condition of uniform ionization density within the chamber, a relation is developed for the ratio of voltages required to overcome the space charge for the two collection polarities. Also, approximate analyses are made for the cases of the ionizing particles originating at the surface of either electrode. There is only rough agreement between the calculations and experimental data. A.

537.542 : 537.531.08

Deficiencies in ionization chamber standards for the röntgen. *See Abstr.* 8441

537.542 : 535.37

8470. A case of ageing of liquid scintillators. M. AGENO, G. CORTELLESSA AND R. QUERZOLI. Letter in *Nuovo Cimento*, **9**, 1242–3 (*Dec.*, 1952) *In Italian.*

The fluorescence yield under γ-rays of recrystallized naphthalene, freshly dissolved in pure xylene increases rapidly at first and then linearly with increase of conc. up to 150 g/l. Solutions kept for 10 months gave a different and irregular curve, the fluorescence having increased for some concs. and decreased for others. S. T. HENDERSON

537.542

8471. Technical questions on the Cherenkov radiation counters. I. P. BASSI AND A. M. BIANCHI. Note in *Nuovo Cimento*, **9**, 1087–91 (*Nov.*, 1952) *In Italian.*

Measurements of Cherenkov radiation energy, as a function of the refractive index, are reported. The energy, emitted by cosmic rays passing through a cylindrical radiator, was detected by means of a

triple coincidence unit, consisting of a photomultiplier, two G.M. counters and ancillary electronic equipment. Apart from the Cherenkov radiation, a fluorescence was observed, its magnitude being comparable with that of the Cherenkov effect. The experimental ratio of the Cherenkov energies in Plexiglass and water, $1 \cdot 39 \pm 0 \cdot 30$, is in good agreement with the theoretical value, $1 \cdot 3$. It is suggested that, for measurements of energy, a water-filled radiator is preferable to one of Plexiglass.

R. S. SIDOROWICZ

537.542

8472. Elimination of dead-time corrections in monitored Geiger-counter X-ray measurements. J. N. Eastabrook and J. W. Hughes. *J. sci. Instrum.*, **30**, 317–20 (*Sept.*, 1953).

A circuit is described for use with Geiger-counter spectrometers which employ a second Geiger counter to monitor the X-ray output. It allows neither counter to record while either is quenched, and thus ensures that the ratio of counts recorded is equal to the ratio of quanta received and is independent of the quench times, the mean X-ray output and the X-ray output waveform. The same principle should be applicable to other methods of monitoring. The circuit described also suppresses the background counts for the fraction of the cycle during which a self-rectified X-ray tube produces no characteristic radiation. A.

537.542 : 621.318.572

8473. A fast coincidence-anticoincidence analyzer. R. L. Garwin. *Rev. sci. Instrum.*, **24**, 618–20 (*Aug.*, 1953).

A modified Rossi circuit has been extended to a form in which it allows the recording of as many as six coincidence and four anticoincidence pulses with a resolving time of 3×10^{-9} sec. All input pulses are negative and of any amplitude >3 volts. A complete schematic is given of the circuit which has operated for six months without possibility of adjustment. A.

537.542

8474. Wilson chamber in magnetic field. M. Cresti, A. Loria and G. Zago. Note in *Nuovo Cimento*, **10**, 843–50 (*June*, 1953) *In Italian.*

A Wilson cloud chamber with a magnetic field of 7000 gauss is now operating at the Laboratorio della Marmolada (2000 m) of the Istituto Nazionale di Fisica Nucleare, Sezione di Padova. A description is given of the cloud chamber and its subsidiary equipment for measuring the momentum of high-energy particles. A.

537.543

8475. Diode characteristic of a hollow cathode. M. L. Babcock, D. F. Holshouser and H. Von Foerster. Letter in *Phys. Rev.*, **91**, 755 (*Aug.* 1, 1953).

Experimental diode characteristics of a hollow spherical cathode coated internally with active material and with two symmetrical apertures opposite to planar anodes are given. The current increases very rapidly at small positive potentials and is always higher than the current in an equivalent planar diode. A. H. W. BECK

537.543 : 536

8476. Application of the thermodynamics of irreversible processes to the theory of the magnetron. P. Lindsay and G. D. Sims. Note in *Proc. Phys. Soc. [London] B*, **66**, 423–5 (*May*, 1953).

The thermodynamics developed by Onsager, Casimir, Callen and de Groot is sketched, leading to matrix equations giving the particle current density in terms of the electric field and temperature gradient together with constant coefficients. A. H. W. BEC

IONIZATION . THERMIONICS 537.56/.

537.

8477. A study of charge exchange by helium ions in metals. G. A. Dissanaike. *Phil. Mag.*, **44**, 1051– (*Oct.*, 1953).

A study has been made of the equilibrium fractio of He^0, He^+ and He^{++} in a helium beam traversi metallic foils of beryllium, aluminium and silver energies from $0 \cdot 13$ to $1 \cdot 1$ MeV. The equilibriu fractions have been found to be independent of t metals used. The ratio σ_l/σ_c of the cross-sections f electron loss and capture respectively by the heliu ions is proportional to v^m, where v is the ion veloci In the exchange $He^0 \rightleftharpoons He^+$ the exponent m is equ to $3 \cdot 08 \pm 0 \cdot 10$ in the energy range $0 \cdot 13$ to $0 \cdot 6$ M studied. In the exchange $He^+ \rightleftharpoons He^{++}$ m appears be constant at $5 \cdot 10 \pm 0 \cdot 12$ for energies betwe $0 \cdot 43$ and $1 \cdot 1$ MeV, but decreases steadily w decreasing energy below this region. For the He ion, the speed for which $\sigma_l = \sigma_c$ is found to $2 \cdot 55$ times that of the orbital electron in the hydrog atom, and is almost exactly twice as great as corresponding speed for the He^+ ion.

537.56 : 523

8478. Collisional effects and the conduction curr in an ionized gas. K. C. Westfold. *Phil. Mag.*, 712–24 (*July*, 1953).

A first approximation to the transport equation the conduction current in a binary ionized gas derived by the iterative methods of Enskog a Chapman. The collision-integrals that arise evaluated in terms of the current density, as sugges by the results of "free-path" theory. It is found t the collisional damping factor is a weighted mean the electron and ion collision frequencies instead the electron collision frequency. In practice difference amounts to a factor 4/3, as predic [Abstr. 5893 (1949)]. When applied to static fie the equation yields Chapman and Cowling's formu without further calculation. Corresponding appro mations are made to the equations of conservati motion and thermal energy. With Maxwell's eq tions these provide a reliable set for the investigat of interactions between an ionized gas in motion a the associated radiation field. The results applicable to the solar atmosphere and the regions of interstellar space. With slight modificati they are also made applicable to a slightly ionized such as the H I regions and the lower ionosphere.

537.562 : 537.542

8479. Drift velocity [W] of electrons in BF_3. A. Bracci and E. L. Zimmer. Letter in *Nuovo Cimento*, **10**, 103–4 (*Jan.*, 1953).

This was obtained by measurements on the rise time of pulses of ionization produced by α-particles in an all-metal parallel plate ionization chamber. Curves of pulse height *v.* gap voltage indicate the effect of successive distillations on the purity of commercial BF_3, and show that the ultimate purity, achieved after four distillations, was the same as that of BF_3 produced from KBF_4 by a given simple method. In the range of E/p from 1 — 5 V cm^{-1} mm^{-1} Hg the values found for W (accurate to ±15%) agree with those of Bistline [Abstr. 1481 (1949)] and not with those of Allen–Rossi (1944); small quantities of impurity did not influence W. J. DUTTON

537.562 : 538.566.2

The transmission of Hertzian waves through strongly ionized gases. *See Abstr.* 8591

537.572 : 539.164

8480. On the "differential ionization" of α-rays in CdS crystals. C. Gerthsen and W. Kolb. *Z. Naturforsch.*, **8a**, 315–17 (*May*, 1953) *In German.*

The number of electrons liberated in a CdS crystal by α-particles, is a similar function of the α-particle velocity to the number of ion pairs produced in a gas. J. HUGHES

537.58

8481. The liberation of positive ions by negative ion bombardment of surfaces. R. H. Sloane and R. M. Hobson. Letter in *Proc. Phys. Soc.* [*London*] *A*, **66**, 663–4 (*July*, 1953).

Positive ions produced at a metal surface by the incidence of $LiCl_2^-$ ions (mass numbers 76 to 81) were analysed in a double mass spectrometer. The positive ion spectrum showed peaks corresponding to mass to charge ratio (M/e) in the range 12 to 95 with predominant peaks in the range 47 to 51 corresponding to Li_2Cl^+: only very small peaks at M/e of 77 and 79 corresponding to $LiCl_2^+$ could be detected. The results suggest that the liberated ions can result from a process other than simple charge transfer.

C. G. MORGAN

537.583

8482. Electron emission from metals as an after-effect of irradiation. K. Seeger. *Z. Phys.*, **135**, *No.* 2, 152–62 (1953) *In German.*

Describes an investigation of the time and temperature dependence of electron emission from metals after irradiation with X-rays, u.v. radiation, visible light and mechanical and glow discharge treatment. The emission appears to take place from regions of atomic dimensions with very low work functions.

C. G. MORGAN

COSMIC RAYS 537.591

537.591 : 523.72 : 551.510.535

On the longitude effect of a corpuscular stream from the sun. *See Abstr.* 8813

537.591.1

8483. S-particles. M. Annis, H. Bridge, H. Courant, S. Olbert and B. Rossi. Letter in *Nuovo Cimento*, **9**, 624–7 (*July*, 1952).

Discusses two events observed in a multiplate cloud chamber operated at 3260 m and triggered by a penetrating shower detector. In each case a charged particle comes to rest in a lead plate and gives rise to a single secondary of near minimum ionization. It is concluded from the observed range and scattering that the secondary particle cannot be an electron. The mass of the primary is estimated as 1420 (+910, −450) electron masses. In addition a further three events of this kind have been observed where it is not certain that the secondary particle is not a decay electron but the primary appears to be heavier than a π- or μ-meson. If it is assumed that these three events also represent the decay of S-particles the mass of the primary deduced from all five events is 1780 (+690, −450) electron masses.

H. ELLIOT

537.591.1

8484. Slow neutrons in the cosmic radiation. I. Y. Fujimoto and T. Tamura. *Progr. theor. Phys.*, **8**, 221–30 (*Aug.*, 1952).

The diffusion of cosmic-ray neutrons in the atmosphere is calculated, using recent experimental value of neutron cross-sections for the computation of the age τ. It is found that the correct boundary condition at the top of the atmosphere is necessary for the analysis of the data at stratosphere. Assuming the neutron sources to be stars, the altitude variation and the absolute density of slow neutrons is obtained and compared with experiments. A.

537.591.1

8485. Study of the soft component of the cosmic radiation at Pic du Midi. G. Baroni, G. Cortini, A. Milone, L. Scarsi and G. Vanderhaege. *Nuovo Cimento*, **9**, 867–85 (*Oct.*, 1952) *In French.*

The soft component at Pic du Midi (43°N lat., 2860 m altitude) has been investigated using Ilford G 5 plates. The differential energy spectra for photons and electrons have been determined from scattering measurements, the data for electrons being obtained from single tracks and that for photons from electron pairs created in the emulsion. The energy spectra so obtained and the relative intensities of electrons and photons show good agreement with the calculations of Richards and Nordheim. The angular distribution of the soft and hard components are closely similar and can be represented to a first approximation by the expression $I(\theta)d\Omega = I_v \cos^{3\cdot5}\theta d\Omega$. H. ELLIOT

537.591.1

8486. A new neutral particle in cosmic radiation? W. Bothe. Note in *Z. Naturforsch.*, **8a**, 393–4 (*June*, 1953) *In German.*

The possibility of the existence of magnetic and electric dipoles as cosmic-ray particles is discussed.

J. HUGHES

537.591.1

8487. An unusual Ω° decay. D. D. Millar and D. I. Page. Letter in *Phil. Mag.*, **44**, 1049–50 (*Sept.*, 1953).

The Ω° (V_1^0) was observed to decay in the cloud chamber and the heavy positive secondary stopped

in the gas of the chamber. No decay product appeared thus indicating that it was a stable particle, probably a proton. The other secondary could have been a π- or μ-meson. H. ELLIOT

537.591.1 : 539.18

8488. The new unstable cosmic-ray particles. G. D. ROCHESTER AND C. C. BUTLER. *Rep. Progr. Phys.*, **16**, 364–407 (1953).

A detailed description is given of the properties of the new unstable particles with masses between $400\,m_e$ and $2200\,m_e$. Wilson cloud chamber experiments have provided definite evidence for the existence of a heavy neutral particle, the V_1^0-particle, of mass $2190\,m_e$, which decays into a proton and a negative π-meson. A somewhat lighter neutral particle, known as a V_2^0-particle, also exists, and possible decay schemes are discussed. The properties of the charged V-particles observed in Wilson cloud chambers are compared with the three main types of charged unstable particles found in photographic emulsions. The three types are the τ-meson, of mass $977\,m_e$, which decays into three charged π-mesons, the κ-particle, of mass about $1100\,m_e$, which decays into a μ-meson, and two or more neutral particles, and the χ-meson, of mass $(900–1500)\,m_e$, which decays into a charged π-meson and one neutral particle. The available data indicate that some of the S-particles found in cloud chambers are identical with the χ-particles, and that the charged V-particles probably consist of a mixture of κ- and χ-particles. The very slight evidence for the existence of charged particles with masses about $500\,m_e$ is also described. A discussion is given of many of the possible decay schemes of the numerous particles, their frequencies of production and lifetimes. 85 references. A.

537.591.15

8489. On the cosmic-ray bursts underground: the interaction of π-meson with nucleon. S. OGAWA. *Progr. theor. Phys.*, **8**, 205–11 (*Aug.*, 1952).

A high-energy μ-meson can produce π-mesons, when its electromagnetic field collides with a nucleon. The energy dependency of the cross-section for this process is analysed from the viewpoint of the perturbation method including higher-order corrections, when only the pseudoscalar (direct) coupling of π-meson with nucleon is assumed. Next, retaining the character of the cross-section thus obtained, a phenomenological cross-section for this process is assumed and applied to the analysis of cosmic-ray bursts underground. It is found that consistency between theory and experiment seems unattainable, when only the direct coupling is talen into account. However, the information obtained from burst experiments underground is discussed. A.

537.591.15

8490. Meson production with latitude cut-off. C. THERRAUX. Letter in *Nuovo Cimento*, **9**, 1029–31 (*Oct.*, 1952).

It is pointed out that recent measurements by Cortini *et al.* on the frequency of penetrating showers produced by the primary cosmic radiation is not inconsistent with plural production when the latitude cut-off in the primary energy spectrum is taken into account. H. ELLIOT

537.591.1

8491. Cloud chamber study of cosmic ray electroni showers under dense materials. I. S. FRANCHETT *Nuovo Cimento*, **10**, 551–63 (*May*, 1953).

Pictures of electron showers have been taken b means of a counter-controlled cloud chamber. Th paper deals essentially with the methods employed i analysing the collected data. As an example, th results obtained with a lead plate 2 cm thick insid the chamber are described. They include angula distributions, distributions according to the numbe of electrons, ratio of photon initiated to electro initiated showers. A

537.591.1

8492. On the contribution of electrons knocked o by μ-mesons to the cosmic-ray showers behind variou thicknesses of lead. G. PFOTZER. Note in *Z. Natu forsch.*, **8a**, 335–6 (*May*, 1953). Longer version *Mitt. Max Planck-Inst. Phys. Stratosphäre, No.* 1 19 *pp.* (1953) *In German.*

A calculation shows that the number of knock-o electron showers increases from 0 to 5·5 per 10 μ-mesons at 4 cm Pb, then falls to 5·0 at 12 cm Pb and does not, therefore substantiate Clay's (194 suggested explanation of the 2nd maximum a 15 cm Pb in the Rossi curve. W. J. SWIATECK

537.591.1

8493. Longitudinal development of extensive a showers. H. MESSEL AND R. B. POTTS. *Nuov Cimento*, **10**, 754–78 (*June*, 1953).

A theory of cosmic-ray showers is presented whic embraces the following features: it is assumed tha the primary radiation consists of nucleons; th nucleons generate the pion component by collisio with nuclei; the charged pions decay into muons; th neutral pions decay into photons which initiate th soft component. Detailed numerical results are give for the average numbers (or intensities) of the variou components at different depths in the atmospher and for different energy ranges (only particles wit energies $>10^3$ MeV are considered in this paper The theory predicts that the charged pion and so components have maxima at about 125 gm/cm^2 an that the number of (high energy) muons increases wit depth, showing no maximum. The radiation i predominantly muons up to about 8000 metres an the number of high energy charged pions at sea leve is much greater than the number of high energ nucleons. This latter feature provides a test of th assumption that the high energy pions do not intera with nuclei in the atmosphere. It is concluded tha high energy charged pions must interact with nucl and that their interaction mean free path is longe than that for nucleons. The total meson componen and the total radiation follow very closely a powe law with the same exponent as that assumed for th primary nucleons. A

537.591.1

8494. On the zenithal distribution of particles extensive showers. M. CRESTI, A. LORIA AND ZAGO. *Nuovo Cimento*, **10**, 779–83 (*June*, 1953) *Italian.*

Zenithal distributions for two average densities particles of extensive air showers have been deduce directly from angular measurements in a clou

amber: these results are in good agreement with ose obtained by other workers using counters. pper limits for the attenuation length values have so been derived. A.

537.591.15

495. On the longitudinal development of air owers according to Fermi's theory of meson production. E. AMALDI, L. MEZZETTI AND G. STOPPINI. *Nuovo Cimento*, **10**, 803–16 (*June*, 1953).

The longitudinal development of an air shower roduced by a primary proton of 10^{14} eV has been alculated numerically, with the method of successive ollisions, under the assumption that in the collision etween two particles the production of pions and ucleons follows the thermodynamic approximation f Fermi's theory. In the high energy region $W \geqslant 5^6$ MeV) there is production of $\pi^{\pm}$ and π^0 esons as well as pairs of nucleons, while in the low nergy region only $\pi^{\pm}$ and π^0 are produced. In the ow energy region the calculations have been done nder two different assumptions: in case *A* the collision is totally inelastic while in case *E*, the energy vailable in the centre of gravity frame of reference s divided equally among the produced mesons and he nucleons taking part in the collision. The development of the various components throughout the tmosphere is given graphically. While the ratio of he penetrating component to the electron component urns out to be of the right order of magnitude in both ases (1% in case *A* and 3% in case *E*) the penetrating omponent is too rich in nucleons, especially in ase *E*. A.

537.591.3

496. Anomalies of the absorption curve of cosmic adiation in lead. M. ABD EL-WAHAB KHALIL. Letter in *Nuovo Cimento*, **9**, 1248–9 (*Dec.*, 1952).

Measurements in Alexandria using a fourfold ounter telescope show anomalies at 15, 27·5 and 37·5 cm Pb. H. ELLIOT

537.591.3

3497. On the absorption of particles generating lectron-nucleon showers. S. A. AZIMOV, A. L. LYUBIMOV AND K. P. RÝZHKOVA. *Dokl Akad. Nauk SSSR*, **90**, *No.* 1, 51–4 (1953) *In Russian.*

A discussion of measurements made at 3860 m n 1951, consisting in counting coincidences between 2 trays of counters separated by C, Fe or Pb absorbers nd arranged to register shower-producing particles. The deduced mean free paths are ~3 times geometrical for all 3 elements. A mechanism is discussed whereby the apparent attenuation in heavy elements may be decreased through the re-absorption within the nucleus of π^0's which in light elements would decay outside and be lost. W. J. SWIATECKI

537.591.3

8498. Interactions with nuclei and production of π-mesons. E. CLEMENTEL AND G. PUPPI. *Nuovo Cimento*, **10**, 197–214 (*March*, 1953) *In Italian.*

Various phenomena, connected with the absorption, scattering and production of π-mesons in nuclear matter, have been investigated using an optical model for the nucleus. With the existing experimental data it is possible to establish that up to about 100 MeV the predominant process is the absorption, while for energies above this value scattering predominates. In the production of mesons in nuclei by protons, account has been taken of the energy loss due to the elastic collisions of protons, which is particularly important near the threshold of production. In this way the observed saturation in the forward production cross-section can be explained. The optical model gives an $A^{2/3}$ dependence for the backward production cross-section. In the photoproduction, the absorption of mesons does not alter the angular dependence of the differential cross-section in nuclear matter, and the yield of charged mesons increases more rapidly than the $A^{2/3}$ law, if an absorption mean free path of the order of $2r_0$ is assumed ($R = r_0 A^{1/3}$). For mesons of about 60 MeV results are consistent with the experimental data if an absorption mean free path between $2r_0$ and $3r_0$ is assumed. A.

537.591.3

8499. Cosmic rays at 60 m.w.e. underground. III. The anomalous scattering of μ-mesons. M. L. T. KANNANGARA AND G. S. SHRIKANTIA. *Phil. Mag.*, **44**, 1091–100 (*Oct.*, 1953).

For Pt II, see Abstr. 7754 (1953). Large-angle scatterings which have been found on 126·6 m of the tracks of relativistic particles in Ilford G5 plates exposed at a depth of 60 m.w.e. underground, are analysed, and are shown to be scatterings of μ-mesons. A cross-section of $(2{\cdot}3 \pm 1) \times 10^{-28}$ cm^2/nucleon is derived for scatterings greater than 7° by μ-mesons with $p\beta > 100$ MeV/c in the cosmic radiation at 60 m.w.e., and a cross-section of $(3{\cdot}4 \pm 1{\cdot}5) \times 10^{-27}$ cm^2/nucleon for a similar scattering by μ-mesons with $p\beta$ in the region (100–600) MeV/c. These cross-sections are shown to be rather too high to be explained in terms of a pure Coulomb scattering at a finite nucleus. Agreement between theory and experiment can be achieved, however, on the assumption of a point charge nucleus. Various mechanisms are examined for a possible explanation of the effect without success, and it is concluded that the scatterings probably represent a weak nuclear interaction of μ-mesons. A.

537.591.5

8500. Deflection of cosmic rays in the solar magnetic field. Y. SEKIDO AND T. YAGI. *J. Geomagn. Geoelect.*, **2**, *No.* 3, 77–80 (1950).

It is pointed out that in order to interpret a sidereal variation of the cosmic-ray intensity in the presence of a solar magnetic field it is necessary to take into account the deflection of the primary particles by such a field. This deflection has been calculated for different values of magnetic rigidity and the results are given in the form of curves. H. ELLIOT

537.591.5

8501. Zenithal dependence of the penetrating component of cosmic radiation. I. F. QUERCIA AND B. RISPOLI. *Nuovo Cimento*, **10**, 357–63 (*April*, 1953).

Two experiments are reported, one at Cervinia (3500 m) and one at Rome, on the zenithal distribution of penetrating particles and mesons. It is found that the penetrating component at sea level can be represented by the law $I(\theta) = I_0 \cos^n \theta$ with $n = 2{\cdot}14$ for

$E = 500$ MeV whereas at 3500 m the distribution does not obey this law. At sea level, moreover, the mesonic component with energy between 500 and 1900 MeV follows very closely the law $\cos^{3\cdot06}\theta$. A.

537.591.5

8502. On the correlation between the cosmic ray intensity and the meteorological conditions. B. TRUMPY AND H. TREFALL. *Physica*, **19**, 636–44 (*July*, 1953).

The results of continuous recording of different components of cosmic rays in the years 1950–1952 are reported. The cosmic ray intensity at sea level is correlated with the air pressure, the height of the 100 mb level and the temperature just below this level. The barometric coefficient a, the height coefficient b and the temperature coefficient c are calculated for the total radiation and two different hard components. They were proved to be statistically significant. The coefficients a_s, b_s and c_s for the soft component alone were calculated from the corresponding coefficients for the hard component and the total radiation. On the basis of these values it may be concluded that a part of the soft component at sea level is not produced by the meson component. A.

537.591.5

8503. Time variations of cosmic ray intensity associated with geomagnetic and solar activity. B. TRUMPY. *Physica*, **19**, 645–67 (*July*, 1953).

On the basis of continuous recording of cosmic rays in the years 1949–1951, changes of the cosmic ray intensity connected with world-wide magnetic disturbances have been studied. The variations of the intensity of three different components of cosmic rays have been investigated in 42 cases of world-wide magnetic storms. The variations are invariably decreases, with a distinct diurnal variation. The magnetic disturbances were recorded at the magnetic observatories Dombås, Rude Skov and Cheltenham. No simple connection exists between the changes in the earth's magnetic field during a storm and the corresponding changes in the cosmic ray intensity. Possible theories for the decreases of the cosmic ray intensity during magnetic storms are discussed. A.

537.591.8

8504. Intensity measurement of Cerenkov light. P. BASSI, A. M. BIANCHI AND C. MANDUCHI. Letter in *Nuovo Cimento*, **9**, 861–3 (*Sept.*, 1952).

The intensity of Cherenkov radiation is measured as a function of penetrating power (energy) of the incident particles. The experimentally found intensity increases rapidly with particle energy, in disagreement with the theory which predicts an almost constant (approaching asymptotic) value in most of the region investigated. G. E. BROWN

537.591.8

8505. Slow heavy mesons from cosmic ray stars. R. L. SETTI AND G. TOMASINI. Letter in *Nuovo Cimento*, **9**, 1244–7 (*Dec.*, 1952).

Discusses two stars observed in plates exposed at maximum altitude of 90 000 ft. In each case a slow heavy meson is ejected which comes to rest in the emulsion and disintegrates with the emission of a single charged secondary. The values obtained fc the masses are 1040 ± 90 and 1380 ± 210 electro masses. The masses of the secondary particles an estimated to be $< 400\, m_e$ and $< 300\, m_e$ respectively. H. ELLIO

537.591.

8506. Production of mesons in several condensin materials. A. BONETTI, N. DALLAPORTA, M. MERLI AND G. DASCOLA. *Nuovo Cimento*, **10**, 215–2 (*March*, 1953) *In Italian.*

Ilford G5 plates, $400\,\mu$ thick, were exposed 2000 m between sulphur, tin and lead blocks: othe plates were exposed in air for comparison. All th π–μ events and σ-stars were observed in order to in vestigate the production of π-mesons in differen materials. From the experimental results, the follow ing ratios for the production cross-sections have bee obtained: $\sigma_S : \sigma_{Sn} : \sigma_{Pb} = 1 : 0{\cdot}9 \pm 0{\cdot}3 : 0{\cdot}5 \pm 0{\cdot}2$ This behaviour of the production cross-section as function of the mass number is different from the on observed in cyclotron experiments, and is likely to ind cate that in this case the production follows a differe mechanism, owing to the greater energies which a involved. In order to explain the decrease of th cross-section with increasing mass number, th known values of the partial cross-sections for meso absorption and scattering are discussed and a model proposed, which considers the plural scattering c mesons in nuclear matter as a prominent phenomeno Following this model, the energy losses and absorptio probabilities of the mesons in the interior of the nucl increase rather quickly with the increase of the nuclea radius, and compensate the increase of the productio of mesons with the increase of the number of nucleon in the primary nucleon–nucleon collision. A

537.591.

8507. On the contribution to the electron com ponent of cosmic radiation in the atmosphere derivin from the decay of the μ-particle. R. STROFFOLIN *Nuovo Cimento*, **10**, 300–7 (*March*, 1953) *In Italian.*

Starting from the experimental spectra of th μ-particle in the atmosphere the contribution to th electron component from the decay of the μ-particle has been calculated. The Bhabha and Chakrabart solution of the diffusion equations has been use taking into account only the first two terms of th series of the solution given by these authors. Th vertical intensity of the electrons with energy greate than 10^7 eV, originating from the μ-particle decay found to be markedly less than generally calculate by other authors (at sea level $I_v = 1{\cdot}0 \times 10^{-3}$ cm^{-2} sec sterad^{-1}); this can be probably justified by the fa that in all preceding calculations the μ-particle wa assumed to decay into two instead of three particles.

537.591.

8508. On the electron component of cosmic radiatio in the atmosphere deriving from the decay of neutretto [π^0-mesons]. D. CADORIN. *Nuovo Cimento*, 1 364–79 (*April*, 1953) *In Italian.*

The contribution from the π^0 meson decay into tw photons to the electron component of the cosmi radiation, in passing through the atmosphere, is calcu lated; the diffusion equations are used with a genera

g function for the photons whose energy dependence taken from the experimental data of the Bristol up, and whose variation with the altitude is derived m an absorption length of 130 g.cm^{-2}. The fusion equations are integrated by a method of cessive approximations, taking into account both ionization energy loss and the variation of the ss-sections for pairs and bremsstrahlung with rgy. The results are normalized on the integral ctra of the total electronic component taken from more recent experimental data and a ratio $\pi^0/\pi^{\pm} =$ 53 of neutral to charged mesons is obtained. The solute values of the intensity obtained in this way not inconsistent with those given by the Bristol up, within the wide limits of the uncertainties ually existing in the knowledge of some processes d in the comparison. A.

537.591.8

09. On the nuclear interaction of fast μ-mesons. DEUTSCHMANN. *Z. Naturforsch.*, **8a**, 308–11 *May*, 1953) *In German.*

A large cloud chamber with a total of 104·5 cm Pb sorbers and a triple coincidence arrangement was ed to obtain 3537 μ-tracks. In the 442 m Pb under servation only 1 secondary proton or α track was und and no penetrating secondaries—the sea level oss-section is therefore $\lesssim 3 \cdot 3 \times 10^{-30}$ cm^2.

W. J. SWIATECKI

537.591.8

10. Production by cosmic rays of helium-3 in eteorites. F. A. PANETH, P. REASBECK AND K. I. AYNE. Letter in *Nature* [*London*] **172**, 200–1 *ug.* 1, 1953).

The theory that a considerable fraction of the helium esent in meteorites may be of cosmic ray origin has en confirmed by an investigation of the distribution helium content and the ratio of He^3 to He^4 in mples taken by bore holes from the interior of the arbo meteorite. In general, both the total helium ntent and the ratio of He^3 to He^4 decrease with stance from the surface, but the ratio shows a aximum a few cm below the present surface of the eteorite; this is interpreted as due to the limited netration of the lower-energy α-particle component the primary cosmic radiation. The He^3 content is nly 27% less than the surface value at a depth of cm. The He^4 of cosmic ray origin in the present eteorite cannot exceed 3·5 times the He^3.

M. W. OVENDEN

MAGNETISM 538

538.11

11. Some magnetic properties of metals. VI. Surce corrections to the Landau diamagnetism and the Haas–van Alphen effect. R. B. DINGLE. *Proc. oy. Soc. A*, **219**, 463–77 (*Oct.* 7, 1953).

For Pt V, see Abstr. 3421 (1953). Calculations are ade of the surface corrections to the Landau diagnetism and the de Haas–van Alphen effect characristic of large systems of electrons. A.

538.113

8512. A note on exchange interactions [in paramagnetic salts]. K. W. H. STEVENS. *Rev. mod. Phys.*, **25**, 166 (*Jan.*, 1953).

Brief theoretical consideration is given to the problem of the exchange interaction between two paramagnetic ions in a crystalline field and under the action of strong spin-orbit coupling. Results are obtained which agree closely with those due to Bleaney and Bowers [Abstr. 5195 (1952)].

E. P. WOHLFARTH

538.113

8513. Magnetic susceptibility of bromine–graphite. R. SMOLUCHOWSKI. *Rev. mod. Phys.*, **25**, 178–81 (*Jan.*, 1953).

Bromine, even in small quantities, is known to alter very radically properties of graphite such as conductivity, Hall effect and others. In particular, the relatively large diamagnetic susceptibility of graphite is rapidly decreased by addition of bromine and the effect cannot be explained by assuming presence of bromine in either molecular or atomic form. It appears that this effect can be interpreted in terms of the Brillouin zone structure of graphite. Using Peierls' theory of diamagnetism of free electrons in a solid and Wallace's results concerning the band structure of graphite an expression is derived which relates the change in the magnetic susceptibility to the change in the number of electrons in the Brillouin zones. The theory is in good agreement with experiment if the effectiveness of bromine in accepting electrons is assumed to be that obtained from Hall effect and conductivity data. The probable influence of lattice imperfections is briefly considered. A.

538.113

8514. Exchange narrowing in paramagnetic resonance. P. W. ANDERSON AND P. R. WEISS. *Rev. mod. Phys.*, **25**, 269–76 (*Jan.*, 1953).

A theoretical discussion of the problem of line shape in the presence of strong exchange interactions. It is assumed that the atoms absorb a single frequency varying over a distribution determined by the local dipole field and also varying randomly in time at a rate determined by the exchange interactions. The final expression for line width is in good agreement with experiment if certain modifications of the theory are made (inclusion of the off-diagonal elements of the dipole interaction energy matrix and of the effects of hyperfine and Stark splitting). E. P. WOHLFARTH

538.114

8515. On the magnetism of magnetic compounds: general treatment of superexchange interaction. M. SHIMIZU. *Progr. theor. Phys.*, **8**, 416–30 (*Oct.*, 1952).

The theories of superexchange interaction developed by Kramers (1934) and Anderson (1950) are more generally reformalized by means of the vector model. The formulation can also be applied to the problem of molecular structure in which a consideration of the various orbital configurations of electrons is required. From an application of this method to the crystal which contains the magnetic ions separated from each other by the negative ions, it is found that magnetic interaction (or superexchange interaction), can

be written in terms of spin operators as well as the ordinary exchange interaction, as Anderson concluded previously. As far as one accepts the assumptions that interatomic exchange integrals are negative and intra-atomic exchange integrals positive, it must be said that superexchange interaction is ferromagnetic if one considers only the intermediate states in which an electron on a negative ion has jumped into an unoccupied orbit of the neighbouring magnetic ion. On the other hand the superexchange interaction is antiferromagnetic if one considers only the intermediate states in which the electron has jumped into the orbit which is already occupied by an electron. Actually two sorts of these interactions will be considered to be co-existent in any magnetic compounds and the antiferromagnetic coupling seems to be predominant in most cases. A.

538.114

8516. Atomic moments in alloys. J. E. GOLDMAN. *Rev. mod. Phys.*, **25**, 108–13 (*Jan.*, 1953).

The saturation moment of ferromagnetic alloys has been considered from the point of view of the collective electron theory. Perturbations in band shape due to the fluctuating lattice potential are considered and are found to be more important in some cases than the simple effects of changing electron density characteristic of the usual treatment of alloys. The influence of order on the moment is treated on the basis of Slater's theory of the relation between the long range order and the energy bands in an alloy. Results of measurements of electronic specific heat and Hall effect are presented which make possible a model capable of explaining the unique effects of the order-disorder transformation in Ni_3Mn on this basis. In other alloys, particularly those which do not follow the Slater–Pauling curve or the classical band model, the saturation properties are attributed to the perturbations in the band resulting from the presence in the lattice of ions with different potentials as seen by the itinerant electrons. The screening of the positive Coulombic charge on these ions is accomplished by fluctuations in local electron density of the Fermi gas in some cases and by localized bound states in other cases. The effect on the magnetic properties in these two alternative cases can be explained and correlated with changes in electrical resistivity on alloying. Atomic moments of the constituent atoms for some ordered alloys have been calculated and are in good agreement with the experimental values found by Shull in neutron diffraction experiments. A.

538.114

8517. The molecular field treatment of antiferromagnetism. J. S. SMART. *Rev. mod. Phys.*, **25**, 327–31 (*Jan.*, 1953).

538.114

8518. The spin-wave theory as a variational method and its application to antiferromagnetism. R. KUBO. *Rev. mod. Phys.*, **25**, 344–51 (*Jan.*, 1953).

The spin-wave theory in a modified form is applied to antiferromagnetism. The interaction between different modes of spin-waves, which is due to the higher order terms omitted in the customary spin-wave treatment, is taken into account in a self-consistent manner. It is shown that the interaction terms cause a change of the frequency spectrum of spin-waves which is equivalent to the existence of an anisotropic field. The upper limits of the ground levels are calculated. The variational method can also be applied to the discussions of the stable configurations of magnetization vectors in anisotropic and external fields, and it is consistent with the molecular field theory.

538.1

8519. A theory of ferromagnetism. L. PAULING. *Proc. Nat. Acad. Sci., U.S.A.*, **39**, 551–60 (*June*, 195

A semi-quantitative discussion based on assumptions regarding the electron configurations of atoms in ferromagnetic metals ("there are about conduction electrons per atom in the transition metals"). Values of the saturation magnetization and Curie temperature are estimated from spectral data and the assumption that the conduction electrons are free. The agreement with experiment is reasonably good. E. P. WOHLFARTH

538.114 : 538.23/

8520. The analysis of magnetization curves. E. STONER. *Rev. mod. Phys.*, **25**, 2–16 (*Jan.*, 1953).

A review of the application of general domain theory and the thermodynamics of magnetization (Stoner and Rhodes) to the analysis of magnetization curves (the determination of the character and extent of the various elementary magnetization changes occurring over any part of the curve). Supplementary magnetic investigations of value in such an analysis are reviewed, including: (1) reversible susceptibility measurements; (2) experiments on the magnetocaloric effect; (3) measurements of the reversible changes of magnetization with temperature; (4) Barkhausen effect experiments. Specific experimental results due to Bates and to Tebble are considered in exemplification of the general discussion. E. P. WOHLFARTH

538.114 : 539

8521. Exchange interactions. C. ZENER AND R. HEIKES. *Rev. mod. Phys.*, **25**, 191–8 (*Jan.*, 1953).

A theoretical review of the types of exchange forces at play in ferromagnetic and other substances, the "atomic model" being assumed relevant for the electrons: (1) Exchange of electrons in the *d* shell of an isolated atom; (2) exchange between the *d* shells of adjacent atoms in a crystal; (3) exchange between the conduction electrons; (4) exchange between conduction electrons and incomplete *d* shells; (5) exchange of valence states between two cations of the same transition element; (6) superexchange. See also Abstr. 4616, 5670, 7195, 8084, 8869 (195 395, 2832 (1952).

538.114 : 539

8522. Ferromagnetism and the band theory. J. C. SLATER. *Rev. mod. Phys.*, **25**, 199–210 (*Jan.*, 1953).

A general review. The Heitler–London–Heisenberg approach to the theory of ferromagnetism is criticized, reviewed, the main objection to this method lying in the effects of the non-orthogonality of atomic wave functions in metals. The Dirac spin operator method is similarly rejected. The alternative approach based on the energy band concept, is described

eral terms. The effects of configurational inter-ons (correlation) are considered. Results of a ulation on the oxygen molecule are briefly cribed in exemplification of the general discussion.
E. P. WOHLFARTH

538.114 : 539.11

3. The theoretical and experimental status of the ective electron theory of ferromagnetism. E. P. HLFARTH. *Rev. mod. Phys.*, **25**, 211–19 (*Jan.*, 3).

general review. Previous theoretical work is ulled. A calculation of the internal energy of a al at 0°K is given for a simple case, using the t binding approximation. The form of the hange energy as a function of interatomic distance magnetization is discussed, the need for a corre-on correction being stressed. The problem of h degeneracy is briefly considered, as is the related blem of the applicability of the usual statistical hanical treatment. Several experimental results considered, including some having a bearing on theoretical discussion. 63 references.
E. P. WOHLFARTH

538.114 : 539.11

4. Models of exchange coupling in ferromagnetic lia. J. H. VAN VLECK. *Rev. mod. Phys.*, **25**, –7 (*Jan.*, 1953).

review, dealing mainly with a "generalized senberg model," which assumes a non-integral nber of electron spins per atom and a continuous istribution of these spins among the different ice sites such that states of higher degree of ization are excluded. Comparison is made with collective electron treatment of ferromagnetism.
E. P. WOHLFARTH

538.22 : 539.185

5. Neutron diffraction studies of various transi-n elements. C. G. SHULL AND M. K. WILKINSON. *v. mod. Phys.*, **25**, 100–7 (*Jan.*, 1953).

Neutron diffraction measurements are reported a series of transition elements as an investigation o their magnetic structures. Scattering data have n taken for W, Mo, Nb, V, Cr, Mn and Fe at ious temperatures as low as 4·2°K, and these data interpreted in terms of the magnetic structure sting in the pure metals. For the first four named ments, no magnetic scattering, either coherent or oherent, is found. Cr and α-Mn are established being antiferromagnetic with Néel temperatures 475°K and 100°K, respectively. Paramagnetic ttering has been observed in manganese at room nperature, and the atomic moments determined Cr and Mn follow the general trend of the Slater–ling curve. Magnetic superstructure effects and gnetic disorder scattering were looked for in n and neither was found. A.

538.22 : 539.185

6. Neutron diffraction studies of zinc ferrite and kel ferrite. J. M. HASTINGS AND L. M. CORLISS. *v. mod. Phys.*, **25**, 114–21 (*Jan.*, 1953).

The chemical and magnetic structures have been estigated at room temperature. In agreement with vious X-ray investigations zinc ferrite has been found to possess a completely regular spinel structure with an oxygen parameter of 0·385 ± 0·002. The diffraction peaks show no evidence of coherent magnetic scattering, whereas the background exhibits normal paramagnetic diffuse scattering. This eliminates the possibility of an antiferromagnetic structure at room temperature. In the case of nickel ferrite, calculated intensities based upon an inverted structure and the Néel model of ferrimagnetism are in good agreement with the observed intensities. A.

538.22 : 539.185

8527. Paramagnetic scattering of neutrons by trivalent ions of [Pr,] Nd and Er. W. C. KOEHLER AND E. O. WOLLAN. *Rev. mod. Phys.*, **25**, 128 (*Jan.*, 1953).

Describes results of neutron diffraction experiments on Pr_2O_3, Nd_2O_3 and Er_2O_3. No coherent scattering was observed between 20°K and room temp. and the diffuse scattering remained constant over this range. The effect of the orbital contribution to the scattering amplitude is briefly considered in attempting to interpret the angular dependence of the diffuse scattering; this is similar in Pr_2O_3 and Nd_2O_3, different from that in the Er oxide. E. P. WOHLFARTH

538.22 : 548.73

8528. Crystal structure and antiferromagnetism of CrSb. B. T. M. WILLIS. *Acta cryst.*, **6**, 425–6 (*May*, 1953).

Describes X-ray measurements between −180° and 650°c. Both the lattice parameters vary anomalously in the neighbourhood of the antiferromagnetic transition temperature (about 420°c), the *c*, *T* and *a*, *T* curves showing points of inflection.
E. P. WOHLFARTH

538.221

8529. The permalloy problem. R. M. BOZORTH. *Rev. mod. Phys.*, **25**, 42–8 (*Jan.*, 1953).

In attempting to explain the unusual magnetic properties of the iron–nickel alloys, single crystals of alloys containing 35 to 100% nickel were prepared, and measurements made of the magnetic crystal anisotropy and magnetostriction as dependent on cooling rate. It is confirmed that there is a large effect of cooling rate on the anisotropy in the region near $FeNi_3$, but the experiments show also a substantial effect between 50 and 85% nickel. Two magnetostriction constants, λ_{100} and λ_{111}, were measured on the same crystals. The effect of cooling rate on magnetostriction was found to be substantial only in the composition range 70 to 80% nickel. When the specimens are quenched, λ_{111} goes through zero for a nickel content just below 80% nickel, a composition very close to that for highest permeability. This is understandable because the magnetostrictive strain caused by movement of the boundary between two domains, each magnetized spontaneously in a [111] direction, depends on λ_{111} alone. The same physical picture predicts that near 45% nickel, where [100] is the direction of easiest magnetization and λ_{100} goes through zero, the permeability *v.* composition curve should again have a maximum. Such a maximum is known to exist, and initial permeabilities as high as 15 000 have been observed. Although simple theory suggests that domain-rotation should occur in

very weak fields when the crystal anisotropy is very small (75% nickel in quenched alloys), nevertheless, rotation involves magnetostrictive strains which prevent μ_0 from becoming infinite. Internal poles are also likely to be formed. In slowly cooled alloys the anisotropy is zero at about 63% nickel; here there are random strains caused by magnetostriction and possibly also by atomic ordering. The principal changes in magnetic properties with composition are explained in terms of the crystal anisotropy and magnetostriction, and their change with heat treatment. A.

538.221

8530. Uniaxial anisotropy of a permalloy crystal. S. KAYA. *Rev. mod. Phys.*, **25**, 49–55 (*Jan.*, 1953).

If Permalloy (76% Ni – 24% Fe) which has been previously quenched from 600°C is annealed at 490°C, its energy content decreases with time of annealing, not monotonically but in two steps. By direct measurement of the time-rate of energy decrease, it was concluded that the first step is connected with formation of short-range order and the second with that of long-range order. The effect of a magnetic field applied during the course of cooling on the maximum permeability is associated mainly with formation of short-range order. Taking into consideration the fact that the saturation of the ordered state is about 4% higher than that of the disordered one, one would expect the short-range order to develop in the form of prolate ellipsoids elongated in the direction of spontaneous magnetization. Torque curves, measured on a disk cut from a Permalloy crystal parallel to the (110) plane and heat treated in a magnetic field showed uniaxial anisotropy, superposed on the ordinary cubic one. This uniaxial anisotropy increases with the formation of short-range order, but the formation of long-range order, followed after that of short-range one, has a tendency to annihilate it. The constricted hysteresis loop, which is characteristic of the Perminvar property, becomes most eminent at the end of short-range order formation. If two neighbouring uniaxial domains are assumed, whose axes intersect perpendicularly with each other, and whose boundary bisects the angle between them, the hysteresis loop of constricted form can easily be calculated. The main characteristic of this model is that the displacement of the boundary cannot take place even in a strong field. A.

538.221

8531. An experimental study of Barkhausen noise in nickel–iron alloys. D. I. GORDON. *Rev. mod. Phys.*, **25**, 56–7 (*Jan.*, 1953).

Describes measurements on Ni–Fe specimens (35%–99·5% Ni) in the baked, annealed or quenched state. The average noise per cycle is related to the composition. A definite correlation with initial permeability is established. E. P. WOHLFARTH

538.221

8532. Some new results on antiferromagnetism and ferromagnetism. L. NÉEL. *Rev. mod. Phys.*, **25**, 58–63 (*Jan.*, 1953).

1. The study of the thermomagnetic properties of a natural single crystal of rhomobohedral iron sesquioxide, Fe_2O_3, by Pauthenet, confirms the hypothesis of the superposition of a fundamental antifer magnetism and a parasitic ferromagnetism. Be 260°K the direction of antiferromagnetism coinci with the ternary axis; above 260°K this direction situated in the plane perpendicular to the tern axis, with complete freedom of orientation in plane. The parasitic ferromagnetism seems to formed of two parts, one isotropic, the other an tropic. The latter, tightly coupled with the direct of antiferromagnetism, can be observed only ab 260°K and in a direction perpendicular to the tern axis. The corresponding spontaneous magnetizat may arise from the local imperfections in the co pensation of the two constituent sublattices of antiferromagnetism, and it is the freedom of orien tion of the antiferromagnetism in the basic pl which permits observation of this spontaneous m netization. 2. Pyrrhotite corresponds closely to molecular formula Fe_7S_8. The crystal struct contains holes: one of the eight sites which could occupied by iron ions is vacant. Bertaut showed t at room temperature these holes form an orde lattice such that the crystal unit of Fe_7S_8 does have the NiAs unit but one much more complicat pseudohexagonal and slightly monoclinic, contain 8 Fe_7S_8. This unit is such that the successive pla of iron perpendicular to the pseudo-hexagonal a are not identical: only the odd-numbered pla contain holes. Because the two sublattices are c stallographically different, imperfect antifer magnetism or ferrimagnetism occur, analogous s that of ferrites. A magnetic study by Benoit, at te peratures above the Curie point, seems to show t the ordered distribution of the holes disappears 560°K. Finally, a thermomagnetic study by Pauthe shows that the pseudo-hexagonal axis, which ordinary temperature is a direction of very diffi magnetization, becomes progressively, at lo temperatures, a direction of easy magnetization.

538.

8533. The low temperature transformation in ferri L. R. BICKFORD, JR. *Rev. mod. Phys.*, **25**, 7 (*Jan.*, 1953).

The general behaviour of magnetite (iron ferr at its low-temperature transformation (*c.* 118°K reviewed. One of the properties which undergoe large change is the magnetocrystalline anisotrc which is larger in magnitude and has a lower s metry below the transformation. The magn symmetry axis below the transition temperature be predetermined by cooling a single crystal thro the transition in a magnetic field, and can be chan from one cube edge to another below the transfor tion by means of a strong magnetic field. Directio pressure also appears to be effective in establish the axis. Hysteresis loop measurements show if a compressive stress is applied along the length rod-shaped specimen cut parallel to [100] as it co through the transition, the specimen is more ea magnetized in this direction. No such effect observed along [110] or [111] directions. Char in dimension occurring at the transition have b measured by means of resistance strain gau cemented along the principal crystallographic di tions. Data were obtained as the crystal warr

ough the transition in the demagnetized state after ing been cooled in various conditions of biasing gnetic field and pressure. It is concluded that the ge changes in magnetic symmetry accompany all changes in crystal structure. The low temature form appears to be orthorhombic, the ximum distortion from cubic symmetry, along 0], amounting to *c.* 0·07%. All three orthorhbic axes can be established unambiguously by oling the crystal through the transformation in a gnetic field along [100] with pressure applied ultaneously along [011]. The change in direction easy magnetization above the transition from [111] [100] is accompanied by a small dimension change 0·002%). Similarities with the behaviour of rium titanate at its ferroelectric Curie temperature pointed out. Evidence for the existence of ilar transformations in the other ferrites is discussed efly. A.

538.221

34. Magnetic study of low temperature transmation in magnetite. H. J. WILLIAMS AND R. M. ZORTH. *Rev. mod. Phys.*, **25**, 79–80 (*Jan.*, 1953).

Describes experiments on magnetocrystalline anisopy effects in a natural magnetic crystal. With an plied field in the (100) plane parallel to the [001] rection, this becomes the easy axis, the [010] rection the hard axis. Intermediate angles of ientation of the field were also investigated, both r the (100) and the (110) plane. An artificial crystal is similarly investigated. Torque curves were also tained, all the measurements being made at liquid $_2$ temperatures. The room temp. anisotropy coicient was found to be $-1{\cdot}44\times10^5$ erg. cm^{-1} for e natural crystal, $-1{\cdot}22\times10^5$ for the artificial ystal. E. P. WOHLFARTH

538.221

35. Magnetic spectra of ferrites. G. T. RADO. *ev. mod. Phys.*, **25**, 81–9 (*Jan.*, 1953).

Discusses briefly the meaning of initial permeability, the principles of its measurement and the nature "dimensional resonance." In considering magnetic ectra containing only a single resonance, typical data n sintered ferrites and on finely divided ferrite powrs are reviewed, and some of the theoretical interetations previously advanced are criticized. The vestigations involving the two natural resonances und at the author's laboratory in a commercial Mg rrite are then summarized, including resonance in ngle-domain particles as a method for identifying spersion mechanisms, experimental evidence for the ertia of domain walls, the nature of internal fields, d the temperature dependence of the natural sonances and of the spectroscopic splitting factor. sing the information obtained from these special udies, the following general hypothesis is advanced: n principle, two natural resonances are present in the agnetic spectrum of any sintered ferrite, and the ngle resonance sometimes observed represents the alescence of two resonances. Reasons are given r expecting this coalescence to occur in some aterials only, as in certain sintered mixed ferrites ntaining Zn ferrite. The new hypothesis is consstent with all presently available data, including new ectra, some containing two resonances, that were recently obtained on pure ferrites at the author's laboratory. Additional confirmatory experiments are described which provide methods for separating or coalescing two resonances, and permit distinguishing between internal fields due to anisotropy and magnetic interactions. The limitations and possibilities of ferrites for obtaining useful microwave permeabilities are discussed from the new viewpoint, the criteria involved in this problem being shown to differ from those used at radiofrequencies. A.

538.221

8536. Note on the high frequency dispersion in nickel zinc ferrites. H. P. J. WIJN, M. GEVERS AND C. M. VAN DER BURGT. *Rev. mod. Phys.*, **25**, 91–2 (*Jan.*, 1953).

Describes measurements of the complex initial permeability as a function of frequency for Ni–Zn ferrites from low frequencies up to 3 kMc/s. The effect of an externally applied tension was also investigated. Only one dispersion region was found to occur. The experiments are stated to show that the dispersion is related to a rotation process.

E. P. WOHLFARTH

538.221

8537. Relaxation processes in ferromagnetism. C. KITTEL AND E. ABRAHAMS. *Rev. mod. Phys.*, **25**, 233–8 (*Jan.*, 1953).

Surveys current theoretical work on spin–spin and spin–lattice relaxation in ferromagnetic substances with reference to ferromagnetic resonance. It is shown that it is possible to give a reasonable explanation of the principal features of the experimental results. The calculations, carried out for nickel in particular, make use of a macroscopic spin–lattice interaction determined by the observed magnetostriction and a pseudo-dipolar spin–spin interaction determined by the observed anisotropy. It is not sufficient to use magnetic dipole coupling alone for either of the two relaxation processes. The zero-point fluctuations in the pseudo-dipolar field play a central role in the development of the theory. A.

538.221

8538. Relaxation effects in the ferromagnetic resonance. R. W. DAMON. *Rev. mod. Phys.*, **25**, 239–45 (*Jan.*, 1953).

The spin-lattice relaxation time, T_1, has been determined in single crystals of nickel ferrite, by using the ferromagnetic resonance effect at a frequency of 9000 Mc/s. At high levels of microwave power, the saturation effect is observed both in the resonance absorption and in the component of magnetization along the static field. T_1 is computed from these data. The experimental method is described, and the results presented. Some of the results have not been encountered before in magnetic resonance, and are not predicted by available theories. Because of this, the relaxation time cannot be calculated from the classical theory of the magnetic resonance. By equating the energy absorbed to the energy transferred to the lattice, a value $T_1 \sim 3\times10^{-5}$ sec is obtained. This is longer than the decay time observed directly, which is less than a few tenths of a microsecond. The results are compared with available theories of the magnetic resonance and spin-lattice interaction. A.

538.221

8539. Antiferromagnetism and antiferromagnetic resonance in a rhombic crystal at $T = 0$. C. J. GORTER. *Rev. mod. Phys.*, **25**, 277–8 (*Jan.*, 1953).

Néel's phenomenological theory of antiferromagnetism at zero temperature has been worked out for a three-dimensional case. When the external magnetic field comes near to a certain hyperbola in the field space lying in the plane through the favoured and the least favoured direction of magnetization, an anomaly occurs. This anomaly consists of a rapid turnover of the two opposed directions of magnetization into the direction perpendicular to the plane just mentioned. At much higher fields the two opposed directions of magnetization will deviate towards the field, and finally antiferromagnetism will go over into paramagnetic saturation. Following the general method of Kittel, Ubbink has investigated antiferromagnetic resonance. At not too high frequencies two resonance fields will be flanking the hyperbola in field space. At higher frequencies one resonance field will decrease and vanish, while the other one will approach the field of paramagnetic resonance. A.

538.221

8540. Observations on antiferromagnetic $CuCl_2 . 2H_2O$ crystals. C. J. GORTER. *Rev. mod. Phys.*, **25**, 332–7 (*Jan.*, 1953).

Four series of observations carried out in the Kamerlingh Onnes Laboratory on $CuCl_2 . 2H_2O$ crystals are reviewed. The magnetization curves confirm the general picture given by the theoretical analysis of Gorter and Haantjes [preceding abstract and Abstr. 7390 (1952)]. At the lower temperature a sharp threshold field is found in the crystallographic *ac* plane with a minimum value of 6500 ϕ; at higher temperature its value increases somewhat. Specific heat measurements reveal the existence of a short-range order tail above the sharp Néel temperature at which antiferromagnetism vanishes. In the investigations on proton magnetic resonance a sharp transition is found between a non-symmetrical paramagnetic resonance diagram and a symmetrical resonance diagram characteristic for antiferromagnetism. In this way it is found that the Néel temperature depends on the direction of the magnetizations. It is possible to follow the turnover of the magnetizations near the threshold field. The position of the protons and the nature of the sublattices have been determined. The sublattices do not exchange position within 10^{-4} sec. Microwave resonances have been observed at 9400 and at 4000 Mc/s. The absorption bands are confined to the neighbourhood of the turnover fields. General agreement with Ubbink's theoretical treatment is found. A.

538.221

8541. Antiferromagnetic resonance. L. R. MAXWELL AND T. R. MCGUIRE. *Rev. mod. Phys.*, **25**, 279–84 (*Jan.*, 1953).

The frequencies at which electronic resonance will occur apparently lie beyond the region now available with conventional microwave equipment for those materials having Curie temperatures well above 0°K. Cr_2O_3, MnO, MnTe and MnSe show a large decrease in the amount of resonance absorption as the material (powdered) is lowered through its Curie temperat with only a small residual absorption remaining in antiferromagnetic region. MnSe has an absorp *v.* temperature hysteresis loop that is correlated a magnetic susceptibility loop previously reported this material. The g values remain constant as absorption decreases. Considerable absorption found at zero static magnetic field for MnO, MnS MnTe. The line widths increase sharply as the t perature of the material approaches the Curie t perature. CoO and VO_2 give no detectable abso tion either above or below their Curie temperatu NiO and CuO show no absorption in the antife magnetic region.

538

8542. Saturation and magnetization of hexage iron oxide compounds. G. W. RATHENAU. *Rev. m Phys.*, **25**, 297–301 (*Jan.*, 1953).

The value of the saturation magnetization at ab lute zero of $BaO.6Fe_2O_3$ and related compounds be explained as due to non-compensated antife magnetism. The Bloch wall formation in sm particles is discussed. One is led to the assumpt that in these materials Bloch walls are nucleatec imperfections. In specimens containing rando oriented large crystals, Bloch wall formation beco appreciable at a positive field strength of the or of $4\pi I_s$. By orienting the crystals in a magnetic f $(BH)_{max}$-values of 3×10^6 gauss oersted have b obtained. The critical diameter for wall forma changes with temperature. An excess of w formed at a different temperature from the tempe ture of measurement may persist in a metasta equilibrium.

538

8543. Experimental study of the coercive force of particles. W. H. MEIKLEJOHN. *Rev. mod. Phys.*, 302–6 (*Jan.*, 1953).

The experiments described test the theory of f particle magnets. Particles of Fe, Co and Ni, of 100–2000 Å, were prepared by electrodeposition in mercury cathode. Their sizes and shapes were de mined with an electron microscope. Experiments coercive force *v.* particle size show, in general ag ment with theory, that the maximum coercive forc Fe particles occurs at about 150-Å and is ab 1000 oersteds, for very small packing factors. coercive force decreases rapidly for smaller partic slowly for larger particles. The rapid decrease particles smaller than 150 Å is attributed to ther fluctuations; this is borne out by measurements at temperatures. Addition of 25% by weight 20-oersted Fe particles to 1250-oersted Fe parti decreases the coercive force to 500 oersteds: thus experiment designed to check the predicted 10 oersteds for particles of 10-to-1 shape anisotropy quires an extremely high percentage of such partic For both Fe and Co, the temperature variation coercive force closely follows that of crystalline an tropy and not that predicted for particles with sh anisotropy. Electron micrographs show that m of these particles are bean-shaped, with axis ratio The extent of the present work is not sufficient evaluation of the contribution of shape anisotropy the coercive force of Fe.

538.221

4. Thin films of ferromagnetic materials. E. C. TTENDEN, JR, AND R. W. HOFFMAN. *Rev. mod. ys.*, **25**, 310–15 (*Jan.*, 1953).

Experimental observations are reported on the gnetic properties of thin evaporated films of nickel. e saturation magnetization follows the general diction of Klein and Smith after somewhat arbi- y modifications on the basis of fitting the Weiss ve for bulk specimens, as suggested by Drigo. alitatively observed properties due to domain ucture follow the predictions of Kittle. The sur- e roughness of the specimens has been carefully ntrolled. Measurements of temperature coefficient resistance have led to modification of the theory of ctron mean free path in thin films. The mean free h is found to vary at small thicknesses, rather than naining constant as assumed by Fuchs and Sond- mer. The surface roughness has been estimated h the help of this theory. The films of nickel have as if surface variations extend into the film proximately 3 angstroms from each surface. A.

538.221

5. Coercive force of precipitation alloys. A. H. ISLER. *Rev. mod. Phys.*, **25**, 316–22 (*Jan.*, 1953).

Cunico, Cunife and the various types of Alnico are ucturally analogous in that at the state of high ercive force the crystal structure of the precipitate is torted from a cubic lattice to a tetragonal lattice. single empirical relation has been derived from the a for these types of materials in which maximum ercive force is directly related to degree of tetra- nality and saturation induction of the precipitate. the basis of the fine particle theory this result sug- ts that not only shape anisotropy but also crystal isotropy, as affected by strain, contributes to the ercive force. This work represents the first cessful attempt to correlate the coercive force of the ious commercial permanent magnet alloys with re fundamental characteristics. A.

538.221

6. Magnetic anisotropy of the iron-group orides. J. W. STOUT AND L. M. MATARRESE. *Rev. d. Phys.*, **25**, 338–43 (*Jan.*, 1953).

The magnetic anisotropy of single crystals of FeF_2 d CoF_2 has been measured over the temperature nge 11 to 340°K. Like MnF_2, the anhydrous luorides of iron and cobalt have the tetragonal rutile ystal structure, and the anisotropy results are com- red with those found by Stout and Griffel (1950) for nF_2. In all three compounds the magnetic sus- ptibility parallel to the crystallographic *c* axis is at om temperatures greater than that in a direction rpendicular to this axis. Because of the orbital gnetic moment the high temperature anisotropy is ch greater for FeF_2 and CoF_2 than for MnF_2. As e temperature is lowered, the anisotropy changes n and at 11°K has large negative values, indicating t the susceptibility parallel to the *c* axis becomes all. This indicates that at low temperatures there an ordered antiferromagnetic arrangement with the mentary magnetic moments aligned parallel and tiparallel to the *c* axis. Such a magnetic structure s been found from neutron diffraction measurements by Shull and Erickson (1951). The anomalous behaviour of the magnetic anisotropy, associated with the antiferromagnetic ordering, is in the case of CoF_2 spread out over a much wider temperature range than in the case of MnF_2 and FeF_2. At the lowest temperatures the anisotropy of MnF_2 varies as T^2, whereas those of FeF_2 and CoF_2 vary as the fourth power of the temperature. A.

538.221

8547. Ferromagnetic domain walls in Ferroxdure. H. P. J. WIJN. *Physica*, **19**, 555–64 (*July*, 1953).

Measurements are given of the magnetic spectrum of Ferroxdure (Magnadure) samples in which the ratio of the contributions of wall displacements and domain rotations to the initial permeability is varied. Evidence of a resonance of domain walls seems to be shown. A.

538.221

8548. Measurement of permeability tensor in ferrites. J. O. ARTMAN AND P. E. TANNENWALD. Letter in *Phys. Rev.*, **91**, 1014 (*Aug.* 15, 1953).

Describes microwave cavity resonance experiments designed to determine the off-diagonal elements of the permeability tensor. The experiments were carried out on a Ni–Zn ferrite sample using a cavity resonating at 9·06 kMc/s in the circular TE_{111} mode which is degenerate, and using d.c. fields up to 5000 oersted.

E. P. WOHLFARTH

538.221

8549. A comparison of the powder patterns on a sample of grain-orientated silicon-iron with those obtained on a single crystal. L. F. BATES AND A. HART. *Proc. Phys. Soc.* [*London*] *A*, **66**, 813–18 (*Sept.*, 1953).

A comparison is made of the powder patterns observed on grains within the surface of a polycrystalline specimen of silicon–iron with those found on the surfaces of a single crystal of the same material. A new pattern not hitherto recorded with a single crystal is described, and the conditions for the appearance of three different sets of patterns on polycrystalline and single crystal specimens are noted; data concerning domain boundary spacings are presented. A.

538.221

8550. A study of Bitter figures on the (110) plane of a single crystal of nickel. L. F. BATES AND G. W. WILSON. *Proc. Phys. Soc.* [*London*] *A*, **66**, 819–22 (*Sept.*, 1953).

Experiments were made by the powder pattern technique to determine the magnetic domain structure of a single crystal of nickel cut so that two easy directions of magnetization lay in the plane of each main surface. The closure domain structure is a very simple one, and from the experimental evidence a model is proposed which is similar to that investigated theoretically by Néel in the case of a single crystal of iron. A.

538.221

8551. Microwave resonance absorption in some ferromagnetic manganese compounds. G. D. ADAM AND K. J. STANDLEY. *Proc. Phys. Soc.* [*London*] *A*, **66**, 823–35 (*Sept.*, 1953).

Microwave resonance absorption has been in-

vestigated at a wavelength of 1·26 cm in powdered samples of manganese arsenide (MnAs), manganese antimonide (MnSb) and manganese bismuthide (MnBi). Experiments were performed over a range of temperatures from −180°C to +300°C, and detailed results are given, including where possible the calculated values of the spectroscopic splitting factor g and the measured resonance line widths. With manganese arsenide a g-value of 3·2 was found at room temperature, and this remained sensibly constant from −180°C to +45°C; above the latter temperature only a very small resonance absorption was detected. For the case of manganese antimonide the g-value ranged from 2·2 at −180°C to 2·6 at +20°C and decreased to about 2·1 near the Curie point, 315°C; in this material a marked decrease in line width with increase in temperature was found above 100°C. With manganese bismuthide a resonance absorption was detected only near −180°C and above +240°C. The g-value at −180°C was estimated to be 2·4. A comparison is made with other published results and their significance briefly discussed in the light of existing theories. A.

538.221

8552. Magnets and magnetism—recent developments. W. SUCKSMITH. *Brit. J. appl. Phys.*, **4**, 257–62 (*Sept.*, 1953).

An account is given of the present state of the subject of ferromagnetism, with particular application to ferromagnetic materials. Brief reference is made to the state of development at the beginning of the century and the significant phenomena and principles discovered since then are discussed. Particular attention is directed to the explanation of the magnetization curves of "hard" and "soft" ferromagnetics. The report deals also with the recently discovered ferromagnetic oxides, a new type of magnetic material offering wide possibilities for future investigation and application. A.

538.221 : 535.343.9–14

8553. Ferromagnetic resonance with waves from a common radiator. K. A. VOLKOVA. *Dokl. Akad. Nauk SSSR*, **89**, *No.* 4, 655–8 (1953) *In Russian.*

Ferromagnetic material as a cylinder (1–6 mm × 15–20 μ dia.), placed in a vacuum at the focus of a beam of radiation from a "common radiator" [Arkad'ev, *Collected works, Akad. Nauk SSSR* (1948) p. 53], acts as an antenna. The size of the induced current, or rather the heat absorbed, i^2R, is measured with a Pt/constantan thermocouple. The dimensions control the mean wavelength employed and an external magnet produces a field up to 13 500 Oe at the specimen: as the field is varied the maximum heating occurs at resonance. Fe has a narrow resonance at 14 mm, $g = 2·05$ which broadens for shorter wavelengths, while g increases to 2·36 at 7·3 mm and an extremely broad resonance is found at 2·4 mm. Ni is similar, with $g = 1·93$ at 14 mm and 2·3 at 9·3 mm. No explanation for the variation of g is given.

D. H. WHIFFEN

538.221 : 536.413.2

Magnetic moment orientation and thermal expansion of antiferromagnetic CrSb. *See Abstr.* 8357

538.221 : 537.31

8554. Some magnetic and electrical properties gadolinium, dysprosium and erbium metals. S. VOLD, F. H. SPEDDING, F. BARSON AND J. F. ELL *Rev. mod. Phys.*, **25**, 129–30 (*Jan.*, 1953).

Describes measurements of the Curie tempera (16 ± 1°C, cf. Trombe) and magnetization curve between 4° and 164°K, H up to 2×10^3 oersted) gadolinium specimen and electrical resistance meas ments between 2·2° and 360°K on Gd, Dy and The resistivity curves show slope discontinuitie 300°, 155° and 80°K respectively, related to mag changes. The room temperature resistivity of abnormally high. E. P. WOHLF

538.221 : 538

8555. Microwave resonance absorption in gadoli metal. A. F. KIP. *Rev. mod. Phys.*, **25**, 22 (*Jan.*, 1953).

The microwave resonance absorption in gadoli metal has been measured at 9000 and 24 000 M The g value in the paramagnetic region is found t 1·95 ± 0·03. In the ferromagnetic region extr line breadth prevents accurate determination of t value. Calculations neglecting effects of line bre give a ferromagnetic g value of 1·94.

538.221 : 53

8556. The physical and magnetic structure of Mishima alloys. E. A. NESBITT AND R. D. HEI REICH. *Rev. mod. Phys.*, **25**, 322–3 (*Jan.*, 1953).

An extension of the authors' work on Alni [Abstr. 4473, 4474 (1952)]. Electron diffrac patterns were obtained from the surface of a s crystal of Fe_2NiAl. A new f.c.c. phase of 10 cell size was observed after heat treatment resu in a coercivity of 435 oersted. Torque curves obtained and the anisotropy coefficient was de for different previous heat treatments. The coe force is believed to arise from the magnetic anisot of the precipitate and the matrix. E. P. WOHLF

538

8557. Forbidden transitions in the paramag resonance spectra of chromium alums. P. BROV AND S. FERRONI. Letter in *Nuovo Cimento*, **9**, 6 (*July*, 1952) *In Italian.*

Theoretical. It is shown that these transitions due to the Stark effect caused by the crystal ele field, and more particularly by its trigonal compo Formulae for the transition probabilities are give L. PINCH

538

8558. The high temperature magnetic susceptib of V, Nb, Ta, W, and Mo. C. J. KRIESSMAN. *mod. Phys.*, **25**, 122–6 (*Jan.*, 1953).

The temperature range of magnetic susceptib measurements has been extended from 1450° 1850°C. In the range from 25°C to the highest perature measured, the susceptibilities of V, Nb Ta decrease with increasing temperature, while susceptibilities of Mo and W increase. A period in the sign of the temperature coefficient of magnetic susceptibility of the transition elemen discussed in relation to various theories of metals

538.222

). Anomalous paramagnetism of copper acetate. LEANEY. *Rev. mod. Phys.*, **25**, 161–2 (*Jan.*, 1953). ummary of work reported in Abstr. 5195 (1952).

538.222

). Some magnetization studies of Cr^{+++}, $^{++}$, Gd^{+++} and Cu^{++} at low temperatures and rong magnetic fields. W. E. HENRY. *Rev. mod. s.*, **25**, 163–4 (*Jan.*, 1953).

leasurements on Cr, Fe and Gd salts show that magnetization obeys the free spin Brillouin tion ($J = S = \frac{3}{2}, \frac{5}{2}, \frac{7}{2}$ respectively) up to over 5% saturation, but that there are considerable ations for Cu salts ($CuSO_4 . 5H_2O$, $CuCl_2 . 2H_2O$). se are discussed; see also Abstr. 2838 (1952); 970 (1953). E. P. WOHLFARTH

538.222

1. Exchange coupling between three iron ions in organic molecules. J. YVON, J. HOROWITZ AND ABRAGAM. *Rev. mod. Phys.*, **25**, 165 (*Jan.*, 1953). or abstract, see Abstr. 967 (1953).

538.222

2. Crystal field theory in the rare earths. R. J. IOTT. *Rev. mod. Phys.*, **25**, 167–9 (*Jan.*, 1953). or fuller version, see Abstr. 6950 (1953).

538.222

3. Paramagnetic resonance absorption in solus of K in liquid NH_3. C. A. HUTCHISON, JR, AND C. PASTOR. *Rev. mod. Phys.*, **25**, 285–90 (*Jan.*, 3).

escribes resonance absorption measurements at m temp. and −33°c. Results are reported for the troscopic splitting factor (2·0010 at 0·425 mol. $^{-1}$, 2·0011 at 0·0365 mol. litre^{-1}), the width of resonance lines and the line shapes and intensities. static paramagnetic susceptibilities are derived n the measurements for different compositions compared with directly measured values. See str. 4530 (1951). E. P. WOHLFARTH

538.222

4. Paramagnetic resonance in phosphors at rowave frequencies. W. D. HERSHBERGER AND N. LEIFER. *Rev. mod. Phys.*, **25**, 291 (*Jan.*, 1953).

538.222

5. Chemical shift of the N^{14} magnetic resonance. MASUDA AND T. KANDA. Note in *J. Phys. Soc. an*, **8**, 432 (*May–June*, 1953).

hifts relative to NO_3^- at room temperature are en for a number of compounds. L. PINCHERLE

538.222

6. Paramagnetic resonance. B. BLEANEY AND W. H. STEVENS. *Rep. Progr. Phys.*, **16**, 108–59 53).

After a brief introduction a general account is given the main phenomena associated with electronic gnetic resonance. Two chapters on line width t experimental technique review the problems olved in detection of the resonance phenomena. short account of the theory of paramagnetism of solid state follows, leading to a derivation of the n-Hamiltonian. The importance of the latter as a thod of describing the resonance results is phasized, the discussion proceeding in terms which , as far as possible, independent of the underlying theory. The ions of the iron (3*d*) group and the rare earth (4*f*) group are then surveyed individually in terms of the spin-Hamiltonian. The influence of exchange interaction is treated in a separate chapter, and the review ends with a brief account of resonance in gases and other special compounds. 103 references. A.

538.222

8567. Fine and hyper-fine structure of paramagnetic resonance spectra in several diluted manganese salts. I. HAYASHI AND K. ÔNO. Note in *J. Phys. Soc. Japan*, **8**, 270–1 (*March–April*, 1953).

538.222

8568. Paramagnetic resonance in an argentic compound. K. D. BOWERS. Letter in *Proc. Phys. Soc.* [*London*] *A*, **66**, 666–7 (*July*, 1953).

Reports results of experiments on powdered specimens of $Ag(phn)_2S_2O_8$, containing Ag^{++} ions and comparable with compounds containing cupric ions, results for which had been reported previously. The measurements were carried out at 290°, 90° and 20°K using radiation of wavenumbers 0·8 and 0·3 cm^{-1}. It was found that $g_{||} = 2·18$, $g_{\perp} = 2·04$.

E. P. WOHLFARTH

538.222 : 536.48 : 536.631

Measurement of the nuclear and electronic contributions to the specific heat of neodymium ethyl sulfate near 1°K. *See Abstr.* 8385

538.222 : 539.382 : 539.62

8569. Magnetomechanical effects in an antiferromagnet, CoO. M. E. FINE. *Rev. mod. Phys.*, **25**, 158 (*Jan.*, 1953).

Describes measurements of Young's modulus [see also Abstr. 1951 (1952)] and internal friction in the neighbourhood of the antiferromagnetic transition temperature (−2°c). Anomalous changes in this range are interpreted in terms of the atomic and domain structure of the substance. E. P. WOHLFARTH

538.23

8570. Resonance phenomena in ferrites. D. POLDER AND J. SMIT. *Rev. mod. Phys.*, **25**, 89–90 (*Jan.*, 1953).

A simple theoretical model is described designed to explain the very high resonance frequencies observed in ferrites. Internal demagnetizing effects (creation of magnetic poles on the surfaces of domain boundaries) are shown to lead to frequency values much larger than those arising from the resonance of the electron spins in the internal anisotropy fields.

E. P. WOHLFARTH

538.23

8571. A Richter type after-effect in ferrites containing ferrous and ferric ions. H. P. J. WIJN AND H. VAN DER HEIDE. *Rev. mod. Phys.*, **25**, 98–9 (*Jan.*, 1953).

Describes measurements of the loss factor tan δ of MnZn and NiZn ferrite specimens as a function of frequency (2–100 kc/s) and temperature (−220° to 0°c). It is found that $\ln f$ is proportional to T^{-1}, where f is the frequency and T the temperature at which δ is a maximum. Expressing the results in terms of a relaxation formula the activation energy is deduced to equal 0·11 eV. The effects of heat treatment on the results were investigated and the loss mechanism is discussed. E. P. WOHLFARTH

538.23 : 539.215

8572. The texture of fine ferromagnetic powders. L. Weil. *Rev. mod. Phys.*, **25**, 324–6 (*Jan.*, 1953).

An application of the author's earlier discussion [Abstr. 1189 (1951)] to the properties of ferromagnetic sponges, in particular to the results obtained by Mayer and Vogt [Abstr. 7393 (1952)] on iron amalgams. E. P. WOHLFARTH

538.24

8573. Heat effects in the magnetization of silicon iron. L. F. Bates and G. Marshall. *Rev. mod. Phys.*, **25**, 17–33 (*Jan.*, 1953).

Describes experiments on the thermal changes accompanying the magnetization of untreated and annealed Si–Fe alloys (0·5–4% Si). The experiments cover both the initial curve and the cyclic curve (fields up to 380 oersted). Experimental errors and difficulties are discussed. The results are analysed [see Abstr. 8520 (1953)], deviations from normal behaviour being briefly discussed. E. P. WOHLFARTH

538.24

8574. Elementary mechanisms of magnetization in mixed oxides of iron and cobalt. C. Guillaud. *Rev. mod. Phys.*, **25**, 64–74 (*Jan.*, 1953).

A theoretical and experimental study of the substances $x\mathrm{Fe_2O_3} \cdot (1-x)\ \mathrm{CoO}\ \ (0{\cdot}5 \leqslant x \leqslant 0{\cdot}6)$. Structure investigations are described. Measurements of magnetostriction were carried out on both isotropic and magnetically oriented specimens, very high values of λ and $d\lambda/dT$ being observed. A theoretical study was made of the remanent magnetization. The general theory of coercivity of the substances is outlined (formally equivalent to small particle theory), the dependence of H_c on density being also considered. The initial susceptibility, the law of approach to saturation and the energy of magnetization are discussed. E. P. WOHLFARTH

538.24

8575. Motion of domain walls in ferrite crystals. J. K. Galt, J. Andrus and H. G. Hopper. *Rev. mod. Phys.*, **25**, 93–7 (*Jan.*, 1953).

Describes experiments on picture frame specimens (Fe_3O_4 and a Ni ferrite) containing only one movable domain boundary. The wall speed was measured as a function of applied field and the relation $v = A(H - H_0)$ established. The complex initial permeability was measured as a function of frequency up to 100 kc/s. The results are interpreted on the basis of domain theory, and values of the damping constant and other parameters characteristic of the wall motion are derived. The value of the effective mass per unit area of the wall is deduced, giving $m = 9{\cdot}5 \times 10^{-11}$ g.cm^{-2} for Fe_3O_4. See also Abstr. 3700 (1952). E. P. WOHLFARTH

538.24

8576. Magnetic energy formulas and their relation to magnetization theory. W. F. Brown, Jr. *Rev. mod. Phys.*, **25**, 131–5 (*Jan.*, 1953).

Present theories of magnetization are based largely on energy formulae. These are incomplete because they rely on a calculation of magnetization work in the absence of strain and of strain work in the absence of magnetization. The present paper summarizes and relates to magnetization theory a culation, already published elsewhere [Abstr. 945 (1951)], in which magnetization and strain assumed from the start to be present simultaneou furthermore, forces are calculated directly, with use of energy arguments until the properties of spe materials are considered. An important resul that the separation of the force on part of a b into a "magnetic" force and a force derivable f "stresses" can be accomplished in more than way. The theory confirms the traditional results fluids; but for elastic solids, it yields terms not pre in the formulae of the traditional theory. T terms may be important in the magnetization proc For a uniformly magnetized ellipsoid they lead nonuniform magnetostriction "form effect" wit mean strain equal to the strain calculated by Becker

538.242 : 538

8577. A new variation of the rotation-by-magnet tion method of measuring gyromagnetic ratios. C Davisson and J. W. Beams. *Rev. mod. Phys.*, 246–52 (*Jan.*, 1953).

In the new method the specimen is in the shap a sphere, the suspension is a torsionless magnetic and the solenoids used in previous measurements replaced by a pair of air-cored electromagnets mou on a common vertical axis. Full details of apparatus and procedure are given and prelimin experimental results outlined. Certain pract disadvantages, such as the magnetic non-uniform of the spherical specimen, have yet to be overcome E. P. WOHLFA

538.

8578. Spontaneous magnetization—techniques measurements. W. Sucksmith, C. A. Clark, D Oliver and J. E. Thompson. *Rev. mod. Phys.*, 34–40 (*Jan.*, 1953).

Measurements on the temperature variation spontaneous magnetization by both the magne thermal and magnetic methods have hitherto b confined to nickel; the extension of these meas ments, calling for greater sensitivity, is discuss To the direct method devised by Weiss and Fo has been added a d.c. amplifier, which allows a sm magnetocaloric rise of temperature to be measu accurately. The original ferromagnetic bala devised by Sucksmith has been improved and r is capable of wider application to measurements magnetic intensity in fields which are due to either core coils or electromagnets. The method is complicated by the presence of any image effect that measurements of $d\sigma/dH$ in high fields can made with considerable precision. Measurements a copper-nickel alloy (27·5% Cu) have been ma and it is shown that the two methods give ident results except in the immediate neighbourhood of Curie temperature, where the thermal measureme give a steeper descent to the temperature axis w little "tail," while the magnetic data indicate a hig Curie temperature with a significant tail. Below Curie temperature the linear relationship between magnetocaloric rise of temperature and the square the intensity magnetization is found as in nickel iron; above this temperature there is pronoun

vature. Measurements have also been carried out a mixed ferrite (MgO ZnO $2Fe_2O_3$). Satisfactory eement between the results by the two methods obtained, both curves differing markedly from law of corresponding states for the ferromagnetic nents. A.

538.245 : 538.665

9. Thermal effects accompanying magnetization ferrimagnetic material. L. F. BATES AND N. P. R. RRY. Note in *Proc. Phys. Soc.* [*London*] *B*, **66**, –10 (*July*, 1953).

Reports measurements on a Ni–Zn ferrite covering teresis cycles with maximum fields 50 410 oersted. e resulting thermal changes may be completely plained in terms of the change of the spontaneous gnetization with temperature, the observed tem- ature change being a linear function of field ngth. E. P. WOHLFARTH

538.248

0. Thermoremanent magnetization of fine vders. L. NÉEL. *Rev. mod. Phys.*, **25**, 293–7 *n.*, 1953).

A brief explanation of the magnetic properties of ferromagnetic grains of single elementary domains, ecially in reference to the influence of time on the gnetization, at a given temperature. Application nade to the interpretation of the thermoremanent gnetization of lavas and clays and to the deter- nation of the direction and intensity of the terrestrial gnetic field in the past. It is shown that, when the stance contains two kinds of fine ferromagnetic ins with clearly different Curie points, it is possible, der certain conditions explained in the text, that constituent having the lowest Curie point becomes gnetized in a direction opposite to the exterior d: there arise, by this phenomenon, interactions ween the grains and the demagnetizing field created the constituent having the highest Curie point. so, in certain cases, the total thermoremanent gnetization is directed inversely to the acting field. cently Nagata found samples of lava in which the rmoremanent magnetization obeys the mechanism is described. In the geophysical interpretation, re will be, then, reason to keep in mind the possi- ity of this curious phenomenon, in considering the ssible inversions of the terrestrial magnetic field. A.

538.27

81. Investigations on magnetic recording media. SCHRADER, A. SIMON AND G. ACKERMANN. *Wiss. Tech. Hochsch. Dresden A*, **2**, 537–45 (1952–53) *In rman.*

Investigations of the oxides mainly used, γFe_2O_3 d Fe_3O_4 with γFe_2O_3 predominating, were carried t in an attempt to establish the factors controlling e dynamic range and the extent of "print-through" the resulting tape. The tests, which are described detail, are: (1) chemical analysis; (2) microscopic amination; (3) density determination; (4) deter- nation of primary-particle size and of size distri- tion by means of the ultramicroscope, sedimenta- n tests, and X-ray examinations. The data obtained m fifteen different prepared oxides are summarized a table. The results suggest that three major factors, crease in particle size, increase in Fe_3O_4 content and decrease in crystal-lattice distortion favour both dynamic range and print-through simultaneously and that of these effects the first predominates. Reduction of lattice distortion by careful oxide preparation is suggested as a means of reducing print-through substantially at the expense of a relatively small loss of dynamic range. H. G. M. SPRATT

ELECTROMAGNETISM . ELECTRODYNAMICS 538.3/.5

538.532

8582. Helmholtz coils for production of powerful and uniform fields and gradients. S. T. LIN AND A. R. KAUFMANN. *Rev. mod. Phys.*, **25**, 182–90 (*Jan.*, 1953).

The magnet is an air core and water-cooled massive Helmholtz type with rectangular cross-section. It consists of a field coil 10 cm in mean radius which can produce 35 000 oersteds at a power of 1700 kW with a uniformity of about 10 ppm at the centre within a region of 10% of the mean radius, and a gradient coil 5·2 cm in mean radius which can produce a gradient of 100 oersteds per cm at a power of 2·5 kW with a uniformity of about 140 ppm within the same region. The fields and gradients are separately controlled. A.

ELECTROMAGNETIC WAVES AND OSCILLATORS 538.56

538.561 : 534.222.2

8583. Magneto-hydrodynamic shock waves in a plasma of infinite conductivity. R. LÜST. *Z. Naturforsch.*, **8a**, 277–84 (*May*, 1953) *In German.*

Conditions at a plane shock are established and compared with the corresponding results for the purely hydrodynamic case. Shocks parallel, perpendicular or obliquely inclined to the magnetic field are discussed separately. The investigation is restricted to non-relativistic motions. R. A. NEWING

538.561 : 621.3.018.4 : 621.317.76

8584. Microwave frequency standard. L. C. HEDRICK. *Rev. sci. Instrum.*, **24**, 565–8 (*Aug.*, 1953).

A high stability u.h.f. source is used. Frequency measurement requires the use of a calibrated communication receiver to measure the difference between a known harmonic of the u.h.f. source and the unknown microwave frequency. Frequencies as high as 27 kMc/s have been measured and the frequency stability is approximately 1 part per million. A.

538.561 : 621.316.722

8585. Circuit for a radio-frequency spectrometer. J. GINDSBERG AND Y. BEERS. *Rev. sci. Instrum.*, **24**, 632–4 (*Aug.*, 1953).

A circuit is described for amplitude stabilization of a regenerative detector for use in nuclear magnetic resonance experiments. A remotely located two-stage d.c. amplifier converts variations in oscillator grid leak voltage into compensating changes in plate

supply potential. The stabilizer circuit adds little stray capacity and does not appreciably affect the oscillator design. The level of oscillation is adjustable from zero to approximately 0·3 volt peak r.f. signal at the detector grid. Once set, it remains essentially constant over the tuning range (4·8 to 6·3 Mc/s). A noise figure of 2 or better is obtained. Circuit parameters for the regenerative detector and the stabilizer are given. A.

538.565 : 621.3.018.75

8586. On the interference of pulse trains. K. S. MILLER AND R. J. SCHWARZ. *J. appl. Phys.*, **24,** 1032–6 (*Aug.*, 1953).

A number of problems arising from the undesired overlapping or time coincidence of pulses from separate periodic pulse trains are considered. The coincidence time fraction is determined for two pulse trains with both a fixed initial phase and a randomly varying initial phase. The coincidence time fraction for these cases is then determined if only pulse coincidences equalling or exceeding a specified interval are considered. Finally, some problems involving more than two pulse trains are briefly discussed. A.

538.565 : 621.396.611.4

8587. The utilization of degenerate modes in a spherical cavity. M. R. CURRIE. *J. appl. Phys.*, **24,** 998–1003 (*Aug.*, 1953).

A general expression is given for calculation of the coupling coefficients between an arbitrary number of modes simultaneously excited in a cavity resonator. The mechanism of energy conversion between modes is discussed for several practical coupling devices. The technique is applied to the unlimited numbers of degeneracies available in spherical geometry and is shown to offer many interesting possibilities. An experimental model of a spherical cavity is described and shown to demonstrate the theory. A.

538.566

8588. The diffraction of electromagnetic waves by a conducting disk and by a circular aperture in a plane conducting screen. W. ANDREJEWSKI. *Z. angew. Phys.*, **5,** *No.* 5, 178–86 (1953) *In German.*

Presents numerical results of the strict theory [Abstr. 7378 (1950)] for both near- and far-field in the case where the circumference and the wavelength are comparable. The comparison with experimental results is satisfactory. The significance of Meixner's edge condition (integrability of the electric field at the edge) is discussed as both mathematically necessary and physically decisive. Other methods, which are approximate, are criticized. T. J. REY

538.566

8589. Intensity and polarization in the diffraction of electromagnetic waves by a slit. II. H. HÖNL AND E. ZIMMER. *Z. Phys.*, **135,** *No.* 2, 196–218 (1953) *In German.*

The method employed in Pt I [Abstr. 5703 (1952)] is now applied to the "magnetic case" (in which the electric field is perpendicular to the length of the slit). It is shown, in particular, that if the width of the slit is small compared with the wavelength the intensity in the "magnetic" case is much greater than in the "electric" case. The relationship between this method and others is examined. P. M. DAVIDSON

538.566 : 621.390

8590. On the theory of diffraction of the elec magnetic wave by mountains. K. FURUTSU. *J. P Soc. Japan*, **8,** 500–24 (*July–Aug.*, 1953).

Equations for the field strength are derived any polarization of the wave and any positions of transmitter and receiver, without making import assumption except that the change of the moun characteristics within the distance of a wavelengt sufficiently small. Also a general equation is obtai for calculations involving both free space propagat and diffraction or reflection by mountains.

538.566.2 : 537.

8591. The transmission of Hertzian waves thro strongly ionized gases. P. VERZAUX. *J. Phys. Radi* **14,** 310–16 (*May*, 1953) *In French.*

Discusses the measurements that may be made an ionized gas by observations of the absorption radio waves in it, with special reference to the case ionization accompanying the propagation of str shock waves through high pressure gases. Afte discussion of the dynamics involved in the latter, paper proceeds to give in detail the theory of absc tion of radio waves in a plasma, and shows h various quantities, e.g. electron densities, r thereby be derived. The paper deals only v theoretical studies. J. D. CRA

538.566.2 : 551.

8592. Oceanic duct and its effect on microw propagation. L. J. ANDERSON AND E. E. GOSSA Letter in *Nature* [*London*] **172,** 298–300 (*Aug.* 1953).

A criterion is given for the trapping of microwa in a duct over the sea which takes account of vary atmospheric stability as a function of air-sea te perature difference and wind velocity. When appl to some results obtained at Cardigan Bay it appe that the suggested model properly describes processes involved. G. M. BRO

538.566.2 : 621.39

8593. The constants in the equation for atmosph refractive index at radio frequencies. E. K. SMITH, AND S. WEINTRAUB. *Proc. Inst. Radio Engrs*, 1035–7 (*Aug.*, 1953).

Recent improvements in microwave techniq have resulted in precise measurements which indic that the conventional constants $K_1 = 79°K/mb$ $K_2' = 4800°K$ in the expression for the refractivity air, $N = (n-1)10^6 = [K_1/T](p + K_2' e/T)$ should revised. Various laboratories appear to have arri at this conclusion independently. Through conside tion of various recent experiments, the relat $N = 77{\cdot}6T^{-1}(p + 4{\cdot}810eT^{-1})$, where p = total pr sure in millibars, e = partial pressure of water vapo in millibars, T = absolute temperature = °C + 2 This expression is considered to be good to 0 in N for frequencies up to 30 000 Mc/s and norma encountered ranges of temperatures, pressure a humidity.

538.566.2 : 621.396.821 : 621.396

8594. A study of individual radio atmospher received simultaneously at two places. P. W. BOWE. *Phil. Mag.*, **44,** 833–40 (*Aug.*, 1953).

Abstr. 3667 (1951) described a method of study

propagation of radio waves of frequency 2–10 kc/s r the surface of the earth, by observing the onses of narrow-band receivers to individual o atmospherics. The present paper describes an nsion of these observations in which the same hod was used simultaneously at two places, nbridge and Aberdeen, 550 km apart. The narrow d receivers at both places were tuned to fre-ncies 7·5, 5·0, 3·5 and 0·6 kc/s. By comparing responses at the two places, the attenuation tors for each frequency could be found. The rces of the atmospherics were located by the eric" direction finding system of the Meteoro-ical Office, supplemented by a direction finder at nbridge. Most of the observations were made at ut noon. The results are presented as tables ing the propagation factor for 1000 km path, for four frequencies studied. It was found that waves frequency 0·6 kc/s are less attenuated than those 3·5 kc/s. The results for 7·5 and 5·0 kc/s indicate t the attenuation is less in winter than in summer. A.

538.566.3

5. Action of the earth's magnetic field on the pagation of short waves. Application to the calcu-on of the "maximum usable frequency." E. GENCE. *Ann. Geophys.*, **9**, *No.* 3, 227–44 (1953) *In nch.*

Uses approximate expressions for the refractive lex [Abstr. 8379 (1951)], leading to an extension the Appleton–Beynon method. A.

538.566.3

6. Theoretical resonance curves in the gyro-eraction of electromagnetic waves in the ionosphere. H. HIBBERD. *Nuovo Cimento*, **10**, 380–5 (*April*, 53).

M. Motzo [Abstr. 2573 (1953)] has considered the ro-interaction of radio waves in the ionosphere hen the disturbing wave is incident vertically. It is ncluded that one would expect to observe always single maximum in the index of interaction as the quency of the disturbing wave is varied through e gyro-frequency. It is possible to show that with ger approximations in the calculations either single double maxima may occur and that there is little ference in the general shape of the resonance curves sulting from vertically incident and obliquely inci-nt disturbing waves. A qualitative outline is given the theory of gyro-interaction of V. A. Bailey 938). A.

MAGNETIC EFFECTS 538.6

538.61

97. Magneto-optical effects and paramagnetic sonance. W. OPECHOWSKI. *Rev. mod. Phys.*, **25**, 4–8 (*Jan.*, 1953).

Gives a formal quantum-mechanical discussion of earlier qualitative treatment by Kastler [Abstr. 5617 951)]. This concerns the effect on the paramagnetic araday rotation of visible light of microwave radia-on giving rise to resonance conditions due to its equency corresponding to an allowed magnetic pole transition between the energy levels of the paramagnetic ions in the substance. A general formula for the rotation is derived and compared with the results obtained by Kastler. E. P. WOHLFARTH

538.614

8598. The ferromagnetic Faraday effect at micro-wave frequencies and its applications. C. L. HOGAN. *Rev. mod. Phys.*, **25**, 253–63 (*Jan.*, 1953).

The theory of the effect is outlined with particular reference to Polder's theoretical analysis of ferro-magnetic resonance phenomena. Apparatus for measuring the Faraday rotation in ferrite specimens is described and representative results given for Ni–Zn and Mg ferrites, using fields up to 5×10^3 oersted and a frequency about 9 kMc/s. The effect of frequency changes was investigated and found to be small between 8 and 11 kMc/s. Related factors, such as the ellipticity and the total insertion loss of the propa-gated waves were also investigated. Applications of the effect which are described include the "microwave gyrator." E. P. WOHLFARTH

538.632

8599. Hall effect in ferromagnetic materials. E. M. PUGH AND N. ROSTOKER. *Rev. mod. Phys.*, **25**, 151–7 (*Jan.*, 1953).

Experimental results are reviewed for Fe, Co, Ni, the Co–Ni and Ni–Cu alloy series. Most of the measurements were made at room temperature. In the case of Ni, data are available from about 10°K to 800°K. In every case studied, the Hall e.m.f. consists of a sum of two terms. The first term is proportional to the magnetizing field and has been called the ordinary Hall effect. Its order of magnitude and sensitivity to variations in temperature and in composition are comparable with the Hall effect in non-ferromagnetic metals. The second term is proportional to the magnetization and has been called the extraordinary Hall effect. At room temperature, the extraordinary effect is usually much larger than the ordinary effect. Large changes in the extraordinary effect may be produced by variations in temperature or composition. In the theory of the ordinary effect, a representation is employed in which conduction may take place in both the *s*- and *d*-bands. This theory appears to be moderately successful in interpreting the experimental data. Various proposals that have been advanced to account for the extraordinary effect are considered briefly. The authors consider that a satisfactory physical basis for this phenomenon has not yet been established. A.

538.632 : 548.7

8600. Electronic Hall effect in NaCl. A. G. REDFIELD. Letter in *Phys. Rev.*, **91**, 753 (*Aug.* 1, 1953).

A coloured NaCl crystal is mounted between an upper (earthed) and a lower electrode, the latter being conducting glass with a potential across it in the "x" direction, the magnetic field being in the "z" direction. A potentiometer adjustment of the mean potential of the lower relative to the upper electrode rotates the crystal field by external means. Current flow in the vertical ("y") direction is recorded by a vibrating reed electrometer. Using light pulses and depolarizing between pulses, the mobility of electrons from F centres is measured and is 250 ± 50 cm^2/volt.sec at 82 ± 2°K in annealed crystals. G. F. J. GARLICK

538.65

8601. Rotational relaxation in nickel at high frequencies. W. P. MASON. *Rev. mod. Phys.*, **25**, 136–9 (*Jan.*, 1953).

Measurements of the ΔE effect and the decrement made by Bozorth, Mason and McSkimin and by Johnson and Rogers are compared with that expected from a calculation of domain wall relaxations for a distribution of domain sizes as determined by the optical measurements of Williams and Walker. At low frequencies the agreement is good but at high frequencies a second relaxation region is indicated. It is shown that this region is consistent with a domain rotation relaxation and, introducing this effect, a good agreement is obtained between theory and experiment for the entire frequency range. A.

538.65 : 534.23

8602. Ultrasonic attenuation in magnetic single crystals. S. LEVY AND R. TRUELL. *Rev. mod. Phys.*, **25**, 140–5 (*Jan.*, 1953).

A striking connection has been found between the magnetic properties and the ultrasonic attenuation properties of a nickel single crystal. The magnetic anisotropy has been detected by measuring the attenuation as a function of applied field intensity. Information about the vibrations of Bloch walls and the number of vibrating walls per unit length has also been obtained. The dependence of the attenuation on magnetic induction for 5–100 Mc/s shear and longitudinal waves propagated in the [1$\bar{1}$0] direction was the same for B parallel to both the [111] and [001] directions. The shear modes induce much greater losses than the longitudinal mode. Similar measurements on a 3·8% Si–Fe crystal showed that the walls in this alloy are not as easily vibrated, i.e. there is a small difference in attenuation between the magnetized and unmagnetized states. At these frequencies this indicates that there is a direct connection between the magnetostrictive constants and the dynamic behaviour of Bloch walls. The elastic constants were computed from velocity measurements, but no ΔE effect was observed. Pulsed ultrasonic techniques as described by Roderick and Truell [Abstr. 3396 (1952)] were used in taking the measurements. The single crystals used were grown from the melt in a hydrogen atmosphere and then oriented so that pure modes of vibration could be propagated. A.

538.652 : 548.73

8603. X-ray determination of the magnetostriction of mixed iron-cobalt oxides. C. GUILLAUD AND M. SAGE. *C.R. Acad. Sci.* [*Paris*] **237**, 313–15 (*July* 27, 1953) *In French.*

Reports low temperature results for 0·56 Fe_2O_3 . 0·44 CoO specimens having very high coercivities. On orienting the specimens in a magnetic field it is found that the axial ratio c/a differs from unity, the difference Δ being a function of temperature: $\Delta = -0{\cdot}74\times10^{-3}$ at 300°K, $-1{\cdot}45\times10^{-3}$ at 130°K [see also Abstr. 8574 (1953)]. E. P. WOHLFARTH

538.653 : 539.219.2

8604. Domain pattern in silicon-iron under stress. L. J. DIJKSTRA AND U. M. MARTIUS. *Rev. mod. Phys.*, **25**, 146–50 (*Jan.*, 1953).

Discusses investigations into the detailed changes in domain structure of ferromagnetic material un externally applied stress. The changes in the dom pattern of grain-oriented silicon steel with large gr size were observed and photographed while the sp men was stressed in tension. Experiments in wh the grain under observation had the {110} plane the surface of the specimen and the ⟨110⟩ direct parallel to the specimen axis, along which tension applied, are discussed in detail. At a load of appro mately 0·2 kg/mm² the original domain patt vanishes. After a transition stage in which, ove certain range of loads, no pattern is visible at all new stress-induced domain pattern appears. behaviour of these patterns in horizontal and verti magnetic fields was studied, and an interpretation both the transition stage and the stress-indu pattern is given. In these experiments the appl stresses are all within the elastic range of the mater In the plastic range, the knowledge of the str induced pattern permits the detection of resid lattice strains in suitably oriented materials.

538.69 : 535.

8605. On magnetophotophoresis. F. C. ROESL *Acta phys. Austriaca*, **7**, *No.* 2, 146 (1953) *In Germ*

Gives a brief discussion of new experiments Steipe [Abstr. 1796 (1953)] on the basis of the autho earlier theoretical work [Abstr. 8050 (1951)] on Ehrenhaft effect. E. P. WOHLFAR

538.69 : 535.

8606. Experiments on magnetophotophoresis powdered silver steel. O. PREINING. *Acta ph Austriaca*, **7**, *No.* 2, 147–54 (1953) *In German.*

Describes experiments on the Ehrenhaft effect usi small ferromagnetic particles. The magnetopho phoretic velocity is determined as a function of fi strength (10^{-1} to 10^3 oersted) and the complex resu are analysed and discussed. E. P. WOHLFAR

MOLECULAR AND ATOMIC STRUCTURE 53

THEORY OF SOLID STATE 539.11

539

8607. Treatment of a model of exchange interacti between an electron and a lattice oscillator [in metal H. HAKEN. *Z. Phys.*, **135**, *No.* 4, 408–30 (1953) *German.*

Discusses a one-dimensional model of a metal wi one electron interacting with a lattice oscillator wi a single harmonic component. Energy, wave numb curves are derived for various values of the wa length of the lattice oscillations; a type of "ba structure" is found in some cases and compared wi that found for electrons in a lattice at rest. T results are compared with those derivable fr perturbation theory. General results analogous those obtained by Jones and Zener are deriv Application is made to the theory of superco ductivity. E. P. WOHLFAR

539.11

8. On a minimum property of the free energy. J. LIDIARD. Note in *Proc. Phys. Soc.* [*London*] *A*, 492–4 (*May*, 1953).

erives the approximate free energy expression for e electron gas with exchange used previously in ussing the thermal properties of free electrons in als [Abstr. 6467 (1950)]. E. P. WOHLFARTH

539.11

9. The cooperative electron phenomenon in dilute ys. J. KORRINGA AND A. N. GERRITSEN. *Physica*, 457–507 (*June*, 1953).

theoretical interpretation is given of the experi- its on the resistance of dilute alloys as a function he temperature (T), the concentration (c) and the ngth of an external magnetic field (H). The rting point in Pt I is a hypothesis which introduces itherto unknown feature of the interaction between conduction electrons, which manifests itself in the sence of an impurity. Expressed in terms of the -electron picture, this hypothesis amounts to the stence of extra states at the Fermi level. The tial localization of these states is, in view of the ertainty relations, limited to a volume of the order that available per foreign ion. A magnetic and hange interaction of such a "local electron" with gnetic ions splits such a state into two states of rgy $\pm \varepsilon_1$ with respect to the Fermi level. It lows that the scattering process is partly of a re- angement type, having a resonance near the Fermi el. The resultant variation of the resistance ρ with t low temperatures can represent the experimental ults quite well. The empirically determined onance energy ε_1 and the resonance width Δ satisfy requirement $\varepsilon_1 \gg \Delta$ whenever a pronounced ximum in the ρ, T-curve is found; the variation of and Δ with c can be understood qualitatively. The n-resonance contribution of the rearrangement lisions to the residual resistance, which depends on ratio of the natural width Γ' of the resonance to should, according to these results, increase with creasing c. A corresponding variation of the resi- al resistance with c can be deduced from the periments. In Pt II it is shown that the spin de- ndence of the rearrangement scattering results in a crease of the resistance in a magnetic field propor- nal to the square of the magnetization of the ion stem; the proportionality factor is the square of the ction of the residual resistance due to the rearrange- ent scattering. From the analysis of the experi- ental results as a function of $x = \mu H/kT$ and $= kT/\varepsilon_1$ it is concluded that the magnetization fers largely from that of a system of free ions, the ost pronounced effect being that it goes to zero if = const and $\lambda \to 0$. The explanation of this effect based on the concept of a "magnetic binding energy" ought about by the interaction of all the metal elec- ons with the magnetic ions. A qualitative theo- tical interpretation of the experimental results is ven in terms of this binding energy. The existence a partial superstructure is deduced from the fluence of annealing on the magnetoresistance at w temperatures in strong fields, and from the irre- rsible effects that were in some cases found in a agnetic field. It is argued that such a structure leads, for small λ, to an extra decrease of the resistance for a given large magnetization. The interpretation of the irreversible effects points to a new type of magnetic transition. Anomalies in the magnetoresistance are found for somewhat higher concentrations, for which $\varepsilon_1 \simeq \Delta$. They are interpreted as being due to a conductivity of the local states. Some consequences of the hypothesis for alloys with non-magnetic ions ($\varepsilon_1 = 0$) are briefly discussed in relation to well-known experimental facts. A.

539.11

8610. Corrections to our paper "On a non-linear approximation of the interatomic force in solid." J. SOMA AND M. OGI. Note in *J. Phys. Soc. Japan*, **8**, 565 (*July–Aug.*, 1953) See Abstr. 1800 (1953).

539.11 : 548.7

8611. Group theory and quantum mechanics of the structure of the transition metals. K. GANZHORN. Note in *Z. Naturforsch.*, **8a**, 330–1 (*May*, 1953) *In German.*

Account of application of the method of a previous paper [Abstr. 7440 (1952)] to the hexagonal and face-centred cubic lattice. W. A. HEPNER

539.11 : 548.7

8612. Electrical interaction of a dislocation and a solute atom. A. H. COTTRELL, S. C. HUNTER AND F. R. N. NABARRO. *Phil. Mag.*, **44**, 1064–7 (*Oct.*, 1953).

In the dilatation field of an edge dislocation in a metal the Fermi energy and ground state of the conduction electrons are both altered. To preserve a constant level of the Fermi surface everywhere, a charge shift occurs by a redistribution of the electrons and an electrical dipole is formed on the dislocation. Mott's estimate of the effective charge on a solute atom in copper is used in a calculation of the electrical interaction of such an atom with an edge dislocation. For the copper-based alloys considered, the calculations suggest that this electrical interaction is between 1/3 and 1/6 of the corresponding elastic interaction. A.

MOLECULAR STRUCTURE 539.13

539.13

8613. On the formation of equations for equilibrium distribution functions of molecules. A. E. GLAUBERMAN. *Dokl. Akad. Nauk SSSR*, **89**, *No.* 4, 659–62 (1953) *In Russian.*

Mathematical. Bogolyubov's equations for distribution functions are established, avoiding as far as possible the usual methods and theses of statistical mechanics. Maxwell and Gibbs distributions follow from more general considerations. Very general distribution functions allow a particularization to be made to the case of forces depending arbitrarily on the co-ordinates (and any derivatives) and velocity of the particle. The divergent solutions separate from the stationary ones a group of "quasi-equilibrium" solutions. J. JACOBS

539.132

8614. The mechanism of the Lewis–Rayleigh afterglow in active nitrogen. L.-H. REINECKE. *Z. Phys.*, **135**, *No.* 4, 361–75 (1953) *In German.*

The first section consists in a discussion of the exist-

ing theories of the L-R-afterglow spectrum of active N_2, based on a revised value of the energy of dissociation of the N_2 molecule, viz. 9·76 eV. The reaction-mechanism in the discharge tube is critically examined, with particular reference to the influence of "foreign" gas molecules on the recombination processes responsible for the afterglow emission. The second section deals with the results of an experimental inquiry which appear to confirm the theoretical arguments.

D. R. BARBER

539.132

8615. Estimation of two-centre integrals. H. Preuss. *Z. Naturforsch.*, **8a**, 270–2 (*April*, 1953) *In German.*

The exchange integrals for 1*s* functions appearing in calculations of chemical bindings are approximated by simple ion- or Coulomb integrals and upper and lower bounds determined. The mean of the two is a fair approximation to the true value where this is known. W. J. SWIATECKI

539.132

8616. Exclusion of dependent co-ordinates in the theory of vibrations of multi-atomic molecules. L. S. Mayants. *Dokl. Akad. Nauk SSSR*, **89**, *No.* 3, 423–6 (1953) *In Russian.*

Mathematical. In order to exploit molecular symmetry additional dependent co-ordinates are often introduced. Using ideas of linear algebra, neater rules for determining additional relations are developed, by which to eliminate superfluous co-ordinates and reduce the order of the matrices T^{-1} and U.

J. JACOBS

539.132 : 534.22

Ultrasonic dispersion in halo-methane vapours. *See Abstr.* 8289

539.132

8617. Electronic spectra of aromatic compounds. M. V. Vol'kenshtein and L. A. Borovinskiĭ. *Dokl. Akad. Nauk SSSR*, **85**, *No.* 4, 737–40 (1952) *In Russian.*

Calculations of the eigenfunctions for naphthalene and anthracene, on the basis of a model for the benzene ring of 6 π-electrons capable of circulating freely around the perimeter of the ring but not able to leave it, yield values for the wavelengths of lines associated with various electron transitions which are in reasonable agreement with experimental ones, reported by Klevens and Platt [Abstr. 3868 (1949)].

R. C. MURRAY

539.132

8618. Interaction of π-electrons in the acetylene molecule. T. Nakamura, K. Ohno, M. Kotani and K. Hijikata. *Progr. theor. Phys.*, **8**, 387–400 (*Oct.*, 1952).

The acetylene molecule has been treated as a system of four π-electrons, and its lower excited energy levels have been calculated using both MO method with configuration interaction and the HL method including ionic-homopolar resonance. The Slater $2p\pi$ atomic orbitals with effective charge 3·18 have been used in each calculation. The results show that the effects of configuration interaction in the MO case or of resonance in the HL case on the energy levels are fairly large, amounting to several electron volts. It is found that the lower "verti excitation energies from the $^1\Sigma_g^+$ ground state 4·88 eV ($^3\Sigma_u^+$), 6·27 eV ($^3\Delta_u$) and 7·59 eV ($^3\Sigma_u^-$, and so on. The effects of the configuration interac and of the ionic-homopolar resonance are discu in connection with the interrelation between the wave functions and the HL ones.

539.

8619. Properties of the hydrogen molecular I. Quadrupole transitions in the ground electr state and dipole transitions of the isotopic ions. D Bates and G. Poots. *Proc. Phys. Soc.* [*London*] **66**, 784–92 (*Sept.*, 1953).

The Einstein spontaneous emission coefficients the oscillator strengths due to the quadrupole mom connecting the vibrational-rotational levels of are evaluated using two-centre wave functions. (v', J')–(v'', J'') lines arising from combinations the following values of the quantum numbers treated: $v' = 0$, 1, 2 or 3; $v'' = 0$; J' and $J'' = 0$ 4, 6 or 8 (with $\Delta J = 0 \pm 2$). In the case of higher harmonics serious cancellation occurs certain of the integrations, but the results should reliable as the calculations do not involve appro mations. The dipole transitions of the isotopic i are also investigated, though less fully.

539.

8620. Nuclear quadrupole resonance of bor A. Bassompierre. *C.R. Acad. Sci.* [*Paris*] 2 39–41 (*July* 6, 1953) *In French.*

Theoretical considerations suggest a quadrup resonance frequency near 1 Mc/s for B^{11} in BO_3'' ion. D. H. WHIFF

539.

8621. Nuclear quadrupole resonance of bromine molecular solids. S. Kojima, K. Tsukada, S. Oga and A. Shimauchi. Letter in *J. chem. Phys.*, 1415–16 (*Aug.*, 1953).

Using the technique of super-regenerative detecti absorption lines of Br^{79} and Br^{81} were recorded, ratio of resonance frequencies being 1·1970 ± 0·00 Resonance frequency is not a smooth function of number of C atoms in the alkyl radical; this irregu relation resembles that between melting point a number of C atoms. J. JAC

539.

8622. Structure of HNCS from microwave spect G. C. Dousmanis, T. M. Sanders, Jr, C. H. Tow and H. J. Zeiger. Letter in *J. chem. Phys.*, 1416–17 (*Aug.*, 1953).

The quadrupole coupling constant of S^{33} is de mined from the hyperfine lines, close to its valu OCS, as $-27·5 \pm 0·8$ Mc/s. An approxim potential well for bending vibrations gives an equ brium angle of 136° and a total amplitude for the zero-point vibration of 26°. J. JAC

539.

8623. On the contribution of the mutual perturba of the localized molecular orbitals to the ch distribution. K. Nukasawa. Note in *J. Phys. Japan*, **8**, 132–3 (*Jan.–Feb.*, 1953).

The localized LCAO MO of 2 parts of a mole are perturbed when the molecule is formed. U

irly crude approximations, the effect of this perturation on dipole moments has been calculated for olecules condensed from C_2H_4, HCHO, CH_4, $_6H_6$, C_4H_6; the μ-difference between 1- and 2-ethyl butadiene is well brought out. J. JACOBS

539.132

524. Hyperconjugation in $C_6H_7^+$ and other hydrocarbon ions. L. W. PICKETT, N. MULLER AND R. S. MULLIKEN. Letter in *J. chem. Phys.*, **21,** 1400–1 (*Aug.*, 1953).

An application of the LCAO MO method to the $_6H_7^+$ ion treated as though it possessed six carbon π lectrons and a quasi-π orbital on the pseudo H_2 atom. wo parameters are introduced, one for the Coulomb tegral on the pseudo H_2 atom, the other permitting djustment of the Coulomb integrals on the carbon oms to allow for the uneven charge distribution and o to attain self-consistency. The hyperconjugation ergy is then calculated as the difference between e energy thus computed and that for the conventional model containing four π electrons on five rbon atoms together with a CH_2 group. Some eneral rules for the energy of hyperconjugation in ydrocarbon ions are discussed. H. H. GREENWOOD

539.132

525. An LCAO MO self-consistent field calculation of the ground state of H_2O. F. O. ELLISON AND H. SHULL. Letter in *J. chem. Phys.*, **21,** 1420–1 (*Aug.*, 953).

Orthogonal Slater orbitals have been used with the sual effective nuclear charges. The importance of bserving orthogonality is indicated in the lowering f the molecular energy towards a value which nearly ives the correct dissociation energy, and in the alue of the dipole moment which is in better agreeent with experiment. The assignment of the nization potentials is considered. H. H. GREENWOOD

539.132

526. Free-electron network model for conjugated ystems. IV. C. W. SCHERR. Letter in *J. chem. hys.*, **21,** 1413–14 (*Aug.*, 1953).

Derives theoretically the curve for bond-length *v.* obile-electron bond-population obtained empirically Pt II (published later in *J. chem. Phys.*), and makes me comments on delocalization-energy values mputed from the eigenvalues tabulated in Pt II.

539.132

527. The distortion of inner shell electrons. J. M. AHILL AND C. R. MUELLER. Letter in *J. chem. hys.*, **21,** 1415 (*Aug.*, 1953).

The influence of the H atom at the bonding distance om Li, C, F is investigated. The effect of 1st-order erturbation on the 1*s* orbitals is small, justifying the sual neglect of inner shell electrons in molecular alculations. In the perturbed eingenfunctions the 2*p* haracter exceeds the 2*s* one. J. JACOBS

539.133

528. Contribution to the study of the dimensions f rigid macromolecules. Comparison of the results of e electron microscope and of the hydrodynamic laws. The fundamental theories of the hydrodynamic ethods used for the determination of the form and dimensions of rigid particles. J. B. DONNET. *J. Chim. phys.*, **50,** 291–300 (*May*, 1953) *In French.*

An outline of the theories which form the bases of various experimental methods for the measurement of particle size in a suspension. These include the theories of diffusion, both of translation and of rotation, for a system of rigid ellipsoidal particles; of viscosity, and of sedimentation. The treatment for both mono- and poly-dispersed media is discussed and experimental verifications of the theories are briefly summarized. H. H. GREENWOOD

539.133

8629. Contribution to the study of the dimensions of rigid macromolecules. Comparison of the results of the electron microscope and of the hydrodynamic laws. II. Experimental methods used in our study. J. B. DONNET. *J. Chim. phys.*, **50,** 301–7 (*May*, 1953) *In French.*

Discusses measurement by the electron microscope. Schematic diagrams and descriptions of the experimental arrangements are given for the measurement of the coefficients of diffusion of translation by the intensity of light absorption; of rotation by flow birefringence; of viscosity by capillary flow; and of sedimentation by ultracentrifuge. The techniques and accuracies are considered rather fully. H. H. GREENWOOD

539.133

8630. Molecular models of amino acids, peptides, and proteins. R. B. COREY AND L. PAULING. *Rev. sci. Instrum.*, **24,** 621–7 (*Aug.*, 1953).

A set of accurate scale models has been developed for use in studies of the structures of amino acids, peptides, and proteins. Models representing atoms, or groups of atoms built from hard wood to the scale 1 in. = 1 Å are connected by a clamping device which maintains desired molecular configurations. These accurate models have been used as substitutes for calculation in investigations of the probable configuration of the polypeptide chain in proteins. Analogous models constructed of rubber-like plastic to the scale 1 in. = 2 Å and connected by snap fasteners are designed for qualitative studies of protein structure. A.

539.133

8631. The length of the molecular chain of *cis*- and *trans*-polydiene. A. A. CHISTORAZUM. *Dokl. Akad. Nauk SSSR*, **89,** *No.* 6, 999–1002 (1953) *In Russian.*

The mean square length of chains of *cis*- and *trans*-polyisoprene were determined using Volkenstein's method; steric hindrance to rotation at each bond was included. The length of a bunch $\sqrt{(\overline{h^2})}$ in the *trans*-chain is 3 times that of a *cis*-chain. This difference in the chain configuration may explain different physical properties of such substances.

J. JACOBS

ATOMIC STRUCTURE . NUCLEUS . ISOTOPES
539.15

539.152.1

8632. Optically induced nuclear magnetization. A progress report. F. BITTER, R. F. LACEY AND B. RICHTER. *Rev. mod. Phys.*, **25,** 174–7 (*Jan.*, 1953).

Following a suggestion by A. Kastler [Abstr. 8171

(1950)], an attempt has been made to produce a high degree of nuclear orientation in Hg^{199} vapour by the absorption of circularly polarized resonance radiation. A method is described for detecting the nuclear orientation by observing the intensity of the π-component of the resonance radiation. No indication of orientation was found. The probable cause for this failure is considered to be the imprisonment and consequent depolarization of the effective component of the resonance radiation. A.

539.152.1

8633. Apparatus for nuclear magnetic resonance. H. S. Gutowsky, L. H. Meyer and R. E. McClure. *Rev. sci. Instrum.*, **24**, 644–52 (*Aug.*, 1953).

Apparatus and procedures are described for the high-resolution measurement of resonance shifts and for the observation of broad line shapes. Included are a discussion of magnet design and a summary of empirical results obtained in the construction and field homogenization of two large permanent magnets. Narrow, complex resonance lines, with components separated by as little as a milligauss, are resolved by a combination of homogeneous applied magnetic field, small samples, and slow-sweep field modulation. Broad absorption line shapes are plotted at fixed frequency by a system incorporating a regenerative oscillator, a narrow band amplifier, a recording potentiometer, and an electronic control for varying the applied magnetic field linearly in time. A simple cryostat provides stable temperatures from 85° to 500°K. In the case of samples with short spin-lattice relaxation times, such as the metals, improved signal-to-noise ratios are obtained by adjusting the oscillator to super-regenerative operation and observing the frequency modulation associated with the dispersive component of the resonance. A.

539.152.1

8634. On nuclear dynamics. A. Kind. Letter in *Nuovo Cimento*, **10**, 176–8 (*Feb.*, 1953) *In Italian.*

The nucleons of a highly excited nucleus are treated statistically. Their interaction is treated as the interaction between the corresponding plane waves, the emission of particles through the transparency of the surface of the nucleus. This model, alternative to the evaporation ones, has been applied to a 100 nucleons nucleus. The main result is that the perturbation of the equilibrium distribution does not depend on the energy of excitation. L. Pincherle

539.152.1

8635. On the binding energy of He^5 and Li^6. G. Morpurgo. *Nuovo Cimento*, **10**, 473–89 (*April*, 1953) *In Italian.*

By making use of wave functions describing a deuteron and an α-particle, the dependence is calculated of the binding energy of Li^6 on the distance between the centre of mass of the α-particle and the centre of mass of the deuteron. The largest binding energy is obtained (if the nuclear parameters are subjected to the saturation conditions) when the deuteron and the α-particle are an infinite distance apart; this is due to the fact that the absolute value of the potential energy increases much slower than the kinetic energy when the distance decreases; probabl the saturation conditions are responsible for th slow increase. For purpose of comparison analogou calculations have been done for He^5. In agreemer with the magnetic moment, in Li^6 the S wave functio gives rise, for each distance, to a higher bindin energy than the P state; the opposite is true for He^5.

539.152

8636. Nuclear binding energies and the *jj*-couplin shell model. A. R. Edmonds. *Proc. Phys. So [London] A*, **66**, 793–9 (*Sept.*, 1953).

Variations with N and Z of nuclear binding energi in the radioactive region are compared with calcul tions of the energies of the lowest states of configura tions of neutrons and protons suggested by the j coupling shell model and experimental data on spin and magnetic moments. Attention is given to th variations of neutron-proton interaction among th "outer" nucleons which are indicated by th experimental binding energies.

539.152

8637. Many-particle systems: derivation of a she model. H. R. Post. Note in *Proc. Phys. So [London] A*, **66**, 649–52 (*July*, 1953).

The many-body problem of N identical particl moving in three dimensions, interacting by ordina harmonic-oscillator pair forces, is solved exactly. fictitious external potential is introduced to do th in a convenient way, rather than employing norm co-ordinates. This model predicts a shell structu and angular momenta in qualitative agreement wi those from the Mayer–Jensen model. G. E. Brow

539.152

8638. Isotopic spin selection rules. I. Radiatio from ^{16}O. D. H. Wilkinson and G. A. Jon *Phil. Mag.*, **44**, 542–7 (*May*, 1953).

Using the $F^{19}(p, \alpha)$ reaction and a NaI(T scintillation spectrometer, γ-transitions from t 7·12 MeV(1^-) and 6·91 MeV (2^+) states of O^{16} the 6·14 MeV (3^-) state have been found, respe tively, to be $< 0{\cdot}008$ and $< 0{\cdot}005$ times as inten as the alternative ground-state transitions. Co parison with intensities predicted by the sing particle model indicates $T = 1$ impurities of amplitu $> 0{\cdot}2\%$ in the 7·12 MeV state and $< 3\%$ in t 6·91 MeV and 6·14 MeV states, in agreement w theoretical estimates [Abstr. 2957 (1953)].

J. J. Wilki

539.153

8639. Isotopic spin selection rules. II. Elect dipole transitions without change of isotopic spin nuclei of $T_z = +1$. D. H. Wilkinson. *Phil. Ma* **44**, 1019–27 (*Sept.*, 1953).

Electric dipole transitions between states of t same isotopic spin in self-conjugate nuclei show v much reduced radiative widths as predicted by t isotopic spin selection rule ($\Delta T = \pm 1$ when $T_z =$ In order to show that this inhibition is due to t isotopic spin rule it must be demonstrated that su transitions are not discouraged in nuclei of $T_z \neq$ This is done by comparing the cross-section radiative capture of thermal neutrons in Li^7, l

nd C^{13} with theoretical values derived with the aid f "uninhibited" values of the electric dipole radiative idths. A.

539.152.1

640. Charge independence and nuclear reactions. . DEVONS. Letter in *Proc. Phys. Soc.* [*London*] *A*, **5**, 665–6 (*July*, 1953).

Discusses the operation of isotopic spin selection ules for the many reactions where both initial nuclei ave $T = \frac{1}{2}$, both final nuclei have $T = 0$, and the ate of the compound nucleus is well defined.

J. M. CASSELS

539.152.1 : 537.533.74

Investigation of nuclear motion by electron diffraction. *See Abstr.* 8449

539.153

641. Hyperfine structure of the metastable triplet ate of helium-3. G. WEINREICH, G. M. GROSOF AND . W. HUGHES. Letter in *Phys. Rev.*, **91**, 195 (*July* 1, 953).

The atomic beam magnetic resonance method was sed. A value of 6739·71 ± 0·05 Mc/s was obtained. he theoretical value is 660 ± 5%, but is subject to ertain corrections.

539.153

642. Effect of nuclear structure on the hyperfine tructure of He^3. V. HUGHES AND G. WEINREICH. etter in *Phys. Rev.*, **91**, 196 (*July* 1, 1953).

The correction to be applied to the $^3S_1$ h.f.s. heoretical value (see preceding abstract) to take ccount of the close approach of the electron to the ucleus is calculated to be $-1{\cdot}2\times10^{-4} \pm 10\%$.

539.153.4

643. Tabulation of the incomplete Fermi–Dirac nctions. G. KELLER AND M. FENWICK. *Astrophys.* , **117**, 437–46 (*May*, 1953).

Provides tables of the incomplete Fermi–Dirac nctions needed to determine the density of free ectrons within the bound orbits of atoms at high mperatures and pressures. A.

539.153.4

644. The wave functions of Al III and Al IV. K. ATTERBACH. *Z. Astrophys.*, **32**, 165–72 (*Aug.*, 1953) *n German.*

K-values for the two excited states of Al have been mputed by the method of Hartree–Fock, and ibulated. After correcting for polarization, the mputed energy-parameter for Al III is in good greement with observation. D. R. BARBER

539.155.2

645. A simple radiometric procedure for the determination of the isotopic composition of lithium salts. V. HERR. *Z. Naturforsch.*, **8a**, 305–7 (*May*, 1953) *In erman.*

The unknown Li sample (in the form of Li_2Co_3) nd a comparison sample are irradiated with neutrons n the presence of a photographic plate. The photoetrically determined blackening due to the α's from $i^6(n, \alpha)H^3$ gives a measure of the Li^6 content.

W. J. SWIATECKI

RADIOACTIVITY . α-, β- AND γ-RAYS 539.16

539.16.08

8646. A simple method of measuring the radioactive substances contained in the air. O. HAXEL. *Z. angew. Phys.*, **5**, *No.* 7, 241–2 (1953) *In German.*

A special type of filter comprising powdered asbestos trapped in filter paper is used to collect the radioactive material from the atmosphere. Studies of half life enable the particular radioactive materials to be identified. J. M. HOUGH

539.16.08

8647. Investigation of the radioactive background rays and their effect. A. SITTKUS, D. GANZ AND E. REMY. *Z. Naturforsch.*, **8a**, 317–22 (*May*, 1953) *In German.*

The influence of fluctuations of the air and earth radioactivity on the background of ionization chambers and counters, as a function of the shielding thickness, was investigated. The decay curve for the activity of snow water is given. J. HUGHES

539.16.08

8648. Sampling and measurement of airborne daughter products of radon. J. H. HARLEY. *Nucleonics*, **11**, 12–15 (*July*, 1953).

Methods of determining the radon concentration in the atmosphere, from measured activities of daughter products collected in dust samples, are described. Experimental results obtained by counting α-activities deposited on mechanical filters are given. Large corrections are required to allow for absorption of α-particles and lack of retention in the filters.

L. R. SHEPHERD

539.16.08

8649. Dosimetry of a kilocurie cobalt-60 source. S. DAVISON, S. A. GOLDBLITH, B. E. PROCTOR, M. KAREL, B. KAN AND C. J. BATES. *Nucleonics*, **11**, 22–6 (*July*, 1953).

A comparison was made of dose rates of radiation from a kilocurie Co^{60} source, as measured by ferrous-ferric, ceric-cerous and methylene blue chemical dosimeters, and the energy deposition in water, measured in an adiabatic type calorimeter. The results indicated that the best yield values for use in the chemical dosimeters are respectively 19·5 and 3·23 μM/litre/1000 rep for the ferrous and ceric types and $2{\cdot}6\times10^5$ rep for the dose required to destroy all but a fraction e^{-1} of the methylene blue (100 μg/cm³ concentration), the rep being taken as 93 ergs/gm. L. R. SHEPHERD

539.163.1 : 539.166

8650. Specific γ-activity, the branching ratio and half-life of potassium-40. P. R. J. BURCH. *Nature* [*London*] **172**, 361–2 (*Aug.* 22, 1953).

The values $3{\cdot}37 \pm 0{\cdot}09$ quanta $sec^{-1}gm^{-1}$, $\gamma/\beta = 0{\cdot}123 \pm 0{\cdot}003$ and $T_{1/2} \leqslant (1{\cdot}31 \pm 0{\cdot}04)\times10^9$ years are derived from some ionization-chamber measurements. Details of the assumptions made in deriving these values are given. J. J. WILKINS

539.163.2

8651. The decay of Mg^{28}. A. H. WAPSTRA AND A. L. VEENENDAAL. Letter in *Phys. Rev.*, **91**, 426 (*July* 15, 1953).

The β- and γ-radiations of Mg^{28} (prepared by an

$\alpha, 2p$ reaction on Mg metal, using 56 MeV α-particles) were examined, and its $\frac{1}{2}$-life determined as $21{\cdot}4 \pm 0{\cdot}6$ hr. An analysis of the β-absorption gave $E_{max} = 0{\cdot}39 \pm 0{\cdot}05$ MeV; the β-decay is to an excited state of Al^{28} with energy 32·2 keV, and the succeeding γ-ray is $E1$ or $M1$. A. O. STANESBY

539.163.2

8652. A metastable state of V^{52}. T. WIEDLING. Letter in *Phys. Rev.*, **91,** 767 (*Aug.* 1, 1953).

Scintillation spectrometer studies of V_2O_5 irradiated with pile neutrons revealed 10 γ's which are fitted into a decay scheme of V^{52} and Cr^{52}, including a 3·7 min and a 16 kV state in V^{52}. W. J. SWIATECKI

539.163.2

8653. Scintillation study of As^{77} and Br^{77}. M. E. BUNKER, R. J. PRESTWOOD AND J. W. STARNER. Letter in *Phys. Rev.*, **91,** 1021 (*Aug.* 15, 1953).

Eight γ-rays from As^{77} have been detected by scintillation techniques, all decaying with half-life $38{\cdot}68 \pm 0{\cdot}09$ hr. Energies and intensities are tabulated. Six further γ-rays in the Br^{77} spectrum have also been detected, and a partial decay scheme is suggested. J. J. WILKINS

539.164

8654. Patterns in alpha spectra of even-even nuclei. F. ASARO AND I. PERLMAN. Letter in *Phys. Rev.*, **91,** 763 (*Aug.* 1, 1953).

For elements between $Z = 88$ and 96, 1, 2 or 3 excited states can be identified as 2+, 4+, 6+; their energy ratios can be understood in terms of rotational levels [Abstr. 6212 (1953)]. Alpha groups leading to 4+ (also 6+) seem to be hindered by factors up to ~400, the lag of the factor for the 4+ levels being approx. linear with Z. W. J. SWIATECKI

539.164

8655. Angular correlation of α-particle and conversion-electron from the decay of ionium. R. R. ROY AND M. L. GOES. *Nature* [*London*], **172,** 360–1 (*Aug.* 22, 1953).

Diffusion cloud chamber observations indicate symmetry about 90° and maxima at 50° and 130°. 17 conversion-electrons were observed per 100 α-particles. J. J. WILKINS

539.164 : 537.534

8656. The interaction between the α-particles and the protons inside the molecule $Bi^{212}H_3$. D. K. YOVANOVITCH AND D. D. YOVANOVITCH. *C.R. Acad. Sci.* [*Paris*] **237,** 43–5 (*July* 6, 1953) *In French.*

Emulsions exposed to the action of gaseous $Bi^{212}H_3$ showed, in addition to α-particles, proton tracks, whose large numbers could not be understood. W. J. SWIATECKI

539.164.2

8657. Alpha-emitting levels of ^8Be with isotopic spin $T = 1$. J. J. WILKINS AND F. K. GOWARD. Letter in *Proc. Phys. Soc.* [*London*] *A*, **66,** 661–2 (*July*, 1953).

$16{\cdot}8 \pm 0{\cdot}2$ MeV (2^+) and $17{\cdot}6 \pm 0{\cdot}2$ MeV levels have been found by $C^{12}(\gamma, 3\alpha)$ experiments. Experimental evidence establishing the $T = 1$ character of the levels is discussed. J. J. WILKINS

539.165

8658. On the β-ray angular correlations. M. YAMADA AND M. MORITA. *Progr. theor. Phys.*, 431–48 (*Oct.*, 1952).

The angular distribution functions of β-rays th are used to obtain the angular correlation functio are calculated taking into account the effect of t nuclear charge. The calculations are performed u to the second forbidden transitions for each β-deca interaction type of the Fermi theory separately, b including the mixture of the nuclear matrix element To obtain the angular correlation functions easi in the case of the mixed nuclear matrix elements th are given in considerably simplified forms in two i teresting cases. Also in the appendix, transformati coefficients $(j_1 3 m_1 m_2 | j_1 3 jm)$ are given.

539.1

8659. Experimental study of the double ionization the K shell of Mn^{55} in the disintegration of Fe^{55} by capture. G. CHARPAK. *C.R. Acad. Sci.* [*Paris*] 23 243–5 (*July* 20, 1953) *In French.*

By means of two semi-cylindrical proportion counters in coincidence (each of solid angle 2π) t frequency of the excitation or ejection of the residu K electron in Mn^{55} was found to be $(3{\cdot}8 \pm 1{\cdot}7)$ 10^{-4}, in agreement with theory. W. J. SWIATEC

539.165 : 539.1

8660. On the $\beta-\gamma$ angular correlation of Sb^1 M. MORITA AND M. YAMADA. *Progr. theor. Phys.*, 449–56 (*Oct.*, 1952).

The $\beta-\gamma$ angular correlation of Sb^{124} is inves gated, taking into account the effect of the Coulor field. It is shown that the linear combination of t three nuclear matrix elements, $\int \beta a$, $\int \beta \sigma \times r$ and in the first forbidden tensor interaction of the Fer theory explains the β-decay of Sb^{124} almost co pletely, and in this case the transition of the nucleus $3(-) - 2(+) - 0(+)$. Many other cases are d cussed.

539.16

8661. Relation between even and odd couplings beta-decay theory. S. FERRONI. Letter in *Nuo Cimento*, **9,** 1103–5 (*Nov.*, 1952).

The two universal Fermi-type interactions [Abs 2420 (1952)] are discussed and the relation betwe them found. Their transformation properties uno the permutation group are contrasted. G. FIE

539.1

8662. Spectrum of the γ-radiation emitted in reaction $^{10}B(n,\alpha)^7Li^*$; $^7Li^* \rightarrow {}^7Li + \gamma$. A. BRAC U. FACCHINI AND A. MALVICINI. Letter in *Nuo Cimento*, **9,** 1237–9 (*Dec.*, 1952) *In Italian.*

A scintillation spectrograph was employed. T excited nucleus is formed in 93% of the cases. T γ-ray energy is $0{\cdot}477 \pm 0{\cdot}010$ MeV. L. PINCHER

539.1

8663. Cascades in the gamma-ray spectrum $^{214}_{84}Po$. F. DEMICHELIS AND R. MALVANO. *Nuo Cimento*, **10,** 405–18 (*April*, 1953).

Coincidence absorption measurements were ma on the γ-ray spectrum of Po^{214}, proving the existe of a strong γ-ray cascade of $1{\cdot}120$–$1{\cdot}761$ MeV resp tively. On the basis of these results the two le schemes suggested by Rutherford (1933) and Surug [Abstr. 2628 (1947)] are compared.

539.166

664. Radiative widths of dipole transitions in light ements. D. H. WILKINSON. Letter in *Phil. Mag.*, 4, 450–2 (*April*, 1953).

Surveys experimental data for 22 transitions in the ght of the theoretical formulae proposed by Weiss-opf. The ratio of experimental to theoretical idths is remarkably constant for $E1$ transitions, ut shows some straggle for $M1$ transitions.

J. M. CASSELS

539.166

665. Gamma-radiation following decay of I^{131}. I. C. HOYT AND J. W. M. DUMOND. Letter in *Phys. ev.*, **91**, 1027 (*Aug.* 15, 1953).

The three γ-rays of approximately 364, 284 and 0 keV have been remeasured with the curved crystal pectrometer. The γ-rays form a Ritz combination, s previously reported [Abstr. 4970 (1949)].

J. J. WILKINS

539.166

666. Angular correlation of the Ni^{60} γ–γ cascade. . M. KLOEPPER. Letter in *Phys. Rev.*, **91**, 1026 *Aug.* 15, 1953).

Experimental results consistent with a 4(E2)2(E2)O ascade are reported. J. J. WILKINS

539.166.08

667. Gamma-ray output of radium. A. GHOSH, J. LASTNER AND G. N. WHYTE. *Nucleonics*, **11**, 70–2 *June*, 1953).

Measurements were made of the ionization pro-uced in an air-filled polystyrene/graphite-walled avity chamber by Pt-encased Ra sources, using the ate-of-discharge method. The wall thickness of the hamber was varied by means of polystyrene caps, in rder to obtain a correction for γ-ray absorption n the walls. Corrections were also made for absorp-on in the air separating source and chamber and or the effect of the Pt source container. Precautions ere taken to avoid scattering from the surroundings, nd it was found that departure from the inverse quare law, with source to chamber distances varied etween 10 and 150 cm, was insignificant. A value f $8{\cdot}44 \pm 0{\cdot}07$ r/hr.mg at 1 cm was derived for the -radiation output from radium. L. R. SHEPHERD

539.166.2

668. Investigation of the excited states of titanium 8 with the aid of γ–γ angular correlations. P. MEYER ND S. SCHLIEDER. *Z. Phys.*, **135**, *No.* 2, 119–24 953) *In German.*

The angular correlation of the γ coincidences from V^{48} source was found, two scintillation counters eing used. Comparison with similar measurements n Na^{22} allowed the effect of positron annihilation adiation to be eliminated. Results show that the rst excited state of Ti^{48} has spin 2, the second pin 4, and both transitions involve quadrupole adiation. F. R. HOLT

539.166.83

669. Auger electron intensities. R. D. HILL. etter in *Phys. Rev.*, **91**, 770 (*Aug.* 1, 1953).

Relative intensities of the L Auger lines for mercury ($Z = 80$) have been computed by using recent theo-tical estimates of internal conversion coefficients bstr. 4587 (1952)]. Good agreement with experi-ment was obtained, assuming a small magnetic-dipole (L_1–K) component in the K X-rays. J. J. WILKINS

539.166.835

8670. On the theory of pair formation in the collision of heavy particles. L. B. OKUN'. *Dokl. Akad. Nauk SSSR*, **89**, *No.* 5, 833–6 (1953) *In Russian.*

The cross-section for pair production in the collision of a heavy particle (e.g. proton or α-particle) with a nucleus is considered for $v/c \ll 1$, where v is the relative velocity of the particles. To obtain this the cross-section for bremsstrahlung is multiplied by a coefficient of conversion of a γ-ray into a pair. Explicit expressions are given for: (*a*) $v/c \gg Z\alpha$, where the Born approximation is employed for the bremsstrahlung; (*b*) $v/c \ll Z\alpha$, where a quasi-classical expression is used for the bremsstrahlung. Results are compared with those of previous authors. G. E. BROWN

NUCLEAR REACTIONS 539.17

539.172 : 537.591.8

Nuclear reactions due to cosmic rays. *See Abstr.* 8504–10

539.172

8671. On the angular correlation of the products of nuclear disintegrations. M. CECCARELLI AND G. T. ZORN. *Nuovo Cimento*, **10**, 540–50 (*May*, 1953).

Angular and energy associations between charged particles emitted in nuclear disintegrations have been investigated, and a marked angular correlation for "small angles" (less than 30°) as well as a probable correlation in energy have been observed for particles having energies of the order of 100 MeV. In this same energy range, an angular correlation for "large angles" (120° to 180°) has also been observed. The possible explanations of the observed angular and energy associations are discussed. A.

539.172

8672. The interaction of π-mesons of the order of a hundred MeV with nucleons and nuclei. J. HEIDMANN. *J. Phys. Radium*, **14**, 481–91 (*July–Aug.–Sept.*, 1953) *In French.*

A summary of recent experiments (up to end of 1952) and an outline of their phenomenological interpretations. A report of relevant topics from the Rochester conference on nuclear physics (Dec., 1952) is included. W. J. SWIATECKI

539.172.13

8673. Nuclear reactions produced by fast nitrogen ions. K. F. CHACKETT, J. H. FREMLIN AND D. WALKER. Letter in *Proc. Phys. Soc.* [*London*] *A*, **66**, 495 (*May*, 1953).

The bombardment of aluminium by N^{14} ions accelerated by the Birmingham 60 in. cyclotron is described. The active nuclei K^{38}, Cl^{34}, P^{32}, Si^{31} and Na^{24} have been identified among the products. Activities have also been produced in Au and Pt.

J. H. FREMLIN

539.172.13

8674. The reactions $He^3(He^3,p)Li^5$ and $T(He^3,p)He^5$. E. ALMQVIST, K. W. ALLEN, J. T. DEWAN AND T. P. PEPPER. Letter in *Phys. Rev.*, **91**, 1022 (*Aug.* 15, 1953).

Protons emitted at 90° and 135° to an 0·24 MeV

He^3 beam were recorded in nuclear emulsions. Both reactions give a high-energy proton peak, superposed on a continuum due to three-body break-up. Q values of $10{\cdot}86 \pm 0{\cdot}15$ MeV and $11{\cdot}18 \pm 0{\cdot}07$ MeV respectively are deduced. J. J. WILKINS

539.172.13

8675. Angular correlations in the reaction $^{23}Na(p, \alpha\gamma)^{20}Ne$. J. SEED. Letter in *Phil. Mag.*, **44**, 921–4 (*Aug.*, 1953).

α–γ correlation measurements at 1255 keV proton energy are reported, showing that the Mg^{24} resonant state is 1^+ and the $1{\cdot}63$ MeV state of Ne^{20} is 2^+. J. J. WILKINS

539.172.13

8676. Excitation of heavy nuclei by the electric field of low-energy protons. C. L. MCCLELLAND AND C. GOODMAN. Letter in *Phys. Rev.*, **91**, 760 (*Aug.* 1, 1953).

Using an NaI(Tl) crystal spectrometer, γ's of apparently nuclear origin were found with bombarding protons of 1·4–2·6 MeV, which is too low for Coulomb barrier penetration. Ta, Pt, Au, Hg, Tl and Bi targets were tried and peaks found at 138 ± 5 keV (also ~ 500 keV?) in Ta, 127 keV (also 90–100 keV?) in Pt, (250? and 450 keV?) in Au, 380 ± 10 keV in Tl. W. J. SWIATECKI

539.172.13

8677. Total cross sections of 408-MeV protons for hydrogen and light elements. J. MARSHALL, L. MARSHALL AND A. V. NEDZEL. Letter in *Phys. Rev.*, **91**, 767 (*Aug.* 1, 1953).

The total cross-sections of H, Li, Be, C, H_2O and D_2O have been measured by a transmission method. The total p–p cross-section agrees with previous measurements of the differential cross-sections near the same energy. The proton cross-sections of the other elements are closely equal to their neutron cross-sections at the same energy, in agreement with the charge symmetry hypothesis. J. M. CASSELS

539.172.13

8678. Excitation curves of the reactions $^{27}Al(p, \alpha)^{24}Mg$ and $^{27}Al(p, \gamma)^{28}Si$. J. G. RUTHERGLEN AND R. D. SMITH. *Proc. Phys. Soc.* [*London*] *A*, **66**, 800–5 (*Sept.*, 1953).

New data are presented on the excitation curve of the reaction $Al^{27}(p, \alpha)Mg^{24}$ in the range of proton energies from 400 keV to 750 keV. Resonances are found which coincide with the previously known γ-ray resonances at 503, 630 and 728 keV. No α-emission is detected from the γ-ray resonances at 652, 677 and 733 keV. The results are discussed in terms of some possible spin and parity assignments of the corresponding levels in Si^{28}. A.

539.172.13

8679. Low intensity lines in the spectrum of the gamma-rays from $^7Li(p\gamma)^8Be(\alpha)^4He$. E. K. INALL AND A. J. F. BOYLE. *Phil. Mag.*, **44**, 1081–90 (*Oct.*, 1953).

Evidence for a γ-ray line at about 12·5 MeV, in the $Li^7(p, \gamma)$ spectrum has been put forward recently by several workers. Although the measurements differ amongst themselves it appears that a line is present to about 10% of the intensity of the well known 17·6 MeV component. Experiments by the author have shown that, in addition to the broad 14·8 MeV line, there are other transitions from the 17·6 MeV state of Be^8 to lower even-states. The results were obtained by observing the emitted γ-ray coincidence with one of the α-particles resulting from the breakup of the even state. The measured α-particle ranges show that transitions occur to Be^8 levels at 4·07, $5{\cdot}31 \pm 0{\cdot}06$ and $7{\cdot}51 \pm 0{\cdot}06$ MeV. The corresponding γ-rays have energies of 13·54 MeV, $12{\cdot}32 \pm 0{\cdot}06$ and $10{\cdot}12 \pm 0{\cdot}06$ MeV and intensities of 2%, 2% and 0·5% of the total intensity. Backgrounds of soft X-radiation from the target backing and energetic α-particles from the reaction $Li^7(p, \alpha)H^4$ complicated the experiment necessitating the performance of check experiments to ensure correct interpretation of the results. In particular the time of flight of the α-particles was used to give a rough indication of their energy and demonstrate the reliability of the coincidence counting.

539.172.1

8680. Nuclear disintegrations caused by 50–125 MeV protons. I. P. E. HODGSON. *Phil. Mag.*, **44**, 1113–2 (*Oct.*, 1953).

The results of measurements on nuclear disintegrations caused by 50–125 MeV protons in photographic emulsion are given. The relative number and the angular and energy distributions of the secondary α-particles and protons have been found and the collision mean free path for protons in emulsion deduced.

539.172.

8681. Spallation of vanadium, manganese, and cobalt with 187 MeV protons. S. G. RUDSTAM. *Phil. Mag.*, **44**, 1131–41 (*Oct.*, 1953).

Describes measurements of the yield of the various spallation products. From the experiments it is concluded that in the spallation of medium weight elements with high energy protons, the total cross section per mass number decreases almost exponentially with increase in the difference between the actual mass number and the mass number of the target nucleus. It is also concluded that for a given mass number the cross-sections of the isobars are approximately represented by a Gaussian distribution.

539.172.

8682. A stripping reaction at low bombarding energy. L. L. GREEN, J. P. SCANLON AND J. C. WILLMOTT. Letter in *Phil. Mag.*, **44**, 919–20 (*Aug.*, 1953).

The neutron angular distribution from $Be^9(d, n)B^{10}$ (3·58 MeV state) has been measured, using 860 keV deuterons. The result indicates a predominant stripping reaction, with $l = 1$. J. J. WILKI

539.172.

8683. Angular distributions of protons from $Na^{23}(d, p)Na^{24}$. S. TAKEMOTO, T. DAZAI AND CHIBA. Letter in *Phys. Rev.*, **91**, 1024 (*Aug.* 15, 1953)

Transitions to the ground state and to two (unresolved) excited states in Na^{24} were observed at a deuteron energy of 1·15 MeV. The neutron captured in the ground state transition seems to have $l_n = 2$. J. M. CASSE

539.172.4

8684. Emission of high-energy γ-quanta in the collision of fast neutrons with protons. I. Ya. Pomeranchuk and I. M. Shmushkevich. *Dokl. Akad. Nauk SSSR*, **87**, *No.* 3, 385–7 (1952) *In Russian.*

An expression for the cross-section of the $p + n \rightarrow p + d$ reaction for high-energy (200 to 250 MeV) nucleons is derived in relation to the cross-section for deuterium photofission. The ensuing γ-spectrum is compared with the π-meson spectrum arising from the collision of two nucleons.

NUCLEAR SCIENCE ABSTRACTS

539.172.4

8685. Reaction cross-section and Q value of the $Cl^{35}(n, \alpha)$ reaction. H. Adler, P. Huber and W. Mälg. *Helv. phys. Acta*, **26**, *No.* 3–4, 349–68 (1953) *In German.*

A parallel-plate ionization chamber filled with Cl gas was used, together with a U-fission chamber as neutron detector and a 19-channel kick-sorter. Corrections and results are given in detail. For neutrons from 3–4 MeV, $Q = 0{\cdot}97 \pm 0{\cdot}16$ MeV. The cross-section in this range of neutron energy increased from 10 to 60 mb, which can be explained by the Gamow factor. F. R. HOLT

539.172.4

8686. Total cross-sections of several elements for 14 MeV neutrons. M. Ageno, G. Cortellessa and L. Querzoli. *Nuovo Cimento*, **10**, 281–99 (*March*, 1953) *In Italian.*

These were measured and a detailed discussion is given of the corrections of transmission data for diffused slow neutrons. No systematic deviations from the one-third power law of the atomic weight were found for nuclear radii, and results are in general agreement, within the limit of standard errors of about 2%, with the statistical theory of Feshbach and Weisskopf. A.

539.172.4

8687. Gamma radiation from inelastic scattering of 2·7 MeV neutrons. V. E. Scherrer, W. L. Smith, J. A. Allison and W. R. Faust. Letter in *Phys. Rev.*, **91**, 768 (*Aug.* 1, 1953).

A Compton spectrometer was used to detect γ-rays emitted from scatterers of copper (0·88 and 1·47 MeV), silver (1·1, 1·5 and possibly 0·63 MeV), and cobalt (1·1 MeV). J. M. CASSELS

539.172.4 : 539.18

8688. Examples of multiple pion production in n–p collisions observed at the cosmotron. W. B. Fowler, R. P. Shutt, A. M. Thorndike and W. L. Whittemore. Letter in *Phys. Rev.*, **91**, 758 (*Aug.* 1, 1953).

An analysis of 2 3-prong cloud chamber events produced by 2000 ± 250 MeV neutrons and attributable to $n + p = n + p + \pi^+ + \pi^-$ and $n + p = p + \pi^+ + \pi^-$. Of the 24 similar events observed, 2 appear to be due to multiple meson production. W. J. SWIATECKI

539.172.4

8689. On the phenomenon of ternary fission with a third fragment of short range. H. de Laboulaye, C. Tzara and J. Olkowsky. *C.R. Acad. Sci* [*Paris*] **237**, 155–7 (*July* 15, 1953) *In French.*

Fission events were observed in a cloud chamber containing a thin uranium source. It is concluded that the ternary fission process concerned occurs 1 ± 3 times per 1000 fissions. Some earlier workers have reported much higher rates. J. M. CASSELS

539.172.4

8690. Flux depression and self-protection in the production of radiocobalt. J. S. Levin and D. J. Hughes. *Nucleonics*, **11**, 8–11 (*July*, 1953).

The self-shielding and depression of the neutron flux in the region of cylindrical samples of cobalt irradiated in the Brookhaven pile, was measured by irradiating Cu foils inside and at the surface of the samples, and in the region of irradiation, with Al replacing the Co. The 4·3 min activity induced was measured in end-window G.M. counters, this activity being chosen because the ratio of resonance to thermal activation is similar to that for Co. The average fluxes in a cylinder 3 cm long by 0·75 cm diameter and in a cylindrical shell $12\frac{1}{4}$ in. long, 1·045 in. outside diameter and $\frac{1}{8}$ in. thick are calculated, in terms of the undisturbed flux, from the results of these measurements. L. R. SHEPHERD

539.172.4

8691. Transitory conditions in a heavy water reactor. V. Raïevski. *J. Phys. Radium*, **14**, 473–7 (*July–Aug.–Sept.*, 1953) *In French.*

The variation in power produced in a heavy water reactor (with deuterium-photo-neutron sources) resulting from the application of a uniform rate of increase of reactivity, is investigated both in the subcritical and supercritical regimes. It is shown that the power level at the moment when the reactor is just critical is independent of the initial reactivity but depends on the previous operational history. In the supercritical regime the reactor is assumed to have a negative temperature coefficient of reactivity and heat transfer to the coolant is taken into account. L. R. SHEPHERD

539.172.4 : 621.311.25 : 620.9

8692. Nuclear power feasibility studies. *Nucleonics*, **11**, 49–64 (*June*, 1953).

A summary of reports given by four American industrial teams, on proposed electrical power-producing reactors. The reactors considered include graphite-moderated, He or liquid Na cooled piles using natural or slightly enriched U fuel; D_2O-moderated natural U reactors with pressurized D_2O or H_2O cooling; fast breeder-type reactors with U^{235} fuel and liquid Na coolant. The contemplated electrical power outputs range from 135 to 550 MW. L. R. SHEPHERD

539.172.4 : 666

8693. Ceramic materials for reactors. *Nucleonics*, **11**, 20–1 (*July*, 1953).

Short summaries of papers given at the 55th annual meeting of the American Ceramic Society, dealing with the properties of a number of ceramics and cermets, which might be suitable refractories for nuclear reactors. L. R. SHEPHERD

539.172.4 : 669

8694. Zirconium. A structural material for nuclear reactors. E. C. Miller. *Nucleonics*, **11**, 27–31 (*July*, 1953).

A review of information on its use in nuclear

power reactors, dealing with separation from hafnium impurity, ores, production and fabrication, and the corrosion resistance of the metal and its alloys. The account is based upon papers given during a symposium at the Western Metals Congress, Los Angeles, March, 1953. L. R. SHEPHERD

ATOM AND MOLECULE BEAMS MESONS . NEUTRONS 539.18

539.18

8695. Radiation of gamma rays upon disintegration of the μ-meson. G. V. SKORNYAKOV. *Dokl. Akad. Nauk SSSR*, **89**, *No.* 3, 431–4 (1953) *In Russian.*

The probability of emission and the energy spectrum of γ-rays emitted by the μ-meson or decay electron are calculated with various assumptions about the form of interaction of the meson, electron and neutrinos (or anti-neutrinos). The probability $\simeq 0{\cdot}04W^0$, where W^0 is the probability of decay without γ emission. The energy spectrum of γ-rays is insensitive to assumptions about the mode of decay. G. E. BROWN

539.18

8696. Nuclear capture of negative μ mesons in photographic emulsions. H. MORINAGA AND W. F. FRY. *Nuovo Cimento*, **10**, 308–18 (*March*, 1953).

Ilford C-2 emulsions were exposed to negative μ-mesons from the University of Chicago cyclotron. The π-mesons were separated from the π-mesons of the same momentum by utilizing the difference in the ranges of the μ and π mesons in Cu. About 24 000 meson tracks which stopped in the emulsion have been studied. In 591 cases (2·4%) the stopped meson is accompanied by the emission of one or more charged particles. A large percentage of these "stars" are one-prong stars. The energy distributions of protons and α-particles from the one-prong stars have been obtained. The general shapes of the energy distribution curves indicate that the protons and α-particles from these stars are mostly evaporation products from a moderately excited nucleus such as silver or bromine. The average energy of the charged particles from these stars is lower than from negative π-meson stars. The negative π-meson contamination is found to be less than 0·3%. In several cases the characteristics of the star make it possible to identify the nucleus in which the meson was captured and to evaluate the energy given to the nucleus. In these cases the energy given to the nucleus is found sometimes to be as high as 45 MeV. A.

539.18

8697. Electrons associated with negative μ-mesons. W. F. FRY. *Nuovo Cimento*, **10**, 490–5 (*April*, 1953).

A study has been made in photographic emulsions of low energy electrons associated with stopped negative μ-mesons from the University of Chicago cyclotron. A total of 1000 meson endings has been studied. Of these mesons, 358 decayed into a high-energy electron and 32 caused a star. The remaining 610 mesons stopped in the emulsion with no associated tracks other than tracks of low energy electrons ($10 < E_e < 100$ keV). A low energy electron track is observed from 17 of the μ^-–e decays (5%). Th energy distribution of the low energy electrons fro the μ–e decays is consistent with the assumption th the low energy electrons are monoenergetic. Th average energy of these electrons is about 17 ke The low energy electrons are thought to be due "Auger" transitions of the negative μ-meson from th atomic capture in the light elements of the emulsio One or more low energy electron tracks are observe from 255 stopped μ-mesons which did not decay cause a star. These electrons are thought to be du to mesonic "Auger" transitions from the heav elements in the emulsion. The large difference in th probabilities of electron ejection from the meson capture in the light and heavy elements (5% as com pared to 44%) is confirmed by a study of low energ electrons associated with negative μ-meson stars.

539.

8698. The classical scattering of neutral meson C. R. MEHL AND P. HAVAS. *Phys. Rev.*, **91**, 393 (*July* 15, 1953).

In a recent paper [Abstr. 7049 (1952)] a theory point particles interacting through neutral meso fields was developed from the point of view of actio at a distance. Equations of motion differing fro those of field theory were obtained. These equation are now used to calculate the scattering of scalar an vector mesons by nucleons. The resulting cros sections are somewhat larger than those previous obtained from field theory, but the difference is small that an experimental distinction hardly appea possible.

539.

8699. The effective cross-section for the reactio $p(\pi^+, 2\pi^+)n$ in the neighbourhood of the threshol B. D'ESPAGNAT. *C.R. Acad. Sci.* [*Paris*] **237**, 139 (*July* 15, 1953) *In French.*

A matrix element calculated in a previous no [Abstr. 7952 (1953)] is introduced into the Heitl equation of the problem. The $(\pi^+, 2\pi^+)$ proce turns out to be very improbable in comparison wi elastic scattering of the π^+, essentially becatuse of th pseudoscalar nature of the π-meson. J. M. CASSE

539.

8700. Measurements of meson masses and relate quantities. F. M. SMITH, W. BIRNBAUM AND W. H BARKAS. Letter in *Phys. Rev.*, **91**, 765 (*Aug.* 1, 1953).

Results of a meson-mass measurement programm based on momentum-range determinations: $m(\pi^+) = 273{\cdot}4 \pm 0{\cdot}2$, $m(\pi^-) = 272{\cdot}5 \pm 3$, $m(\mu^+) = 207{\cdot}0 \pm 0{\cdot}4$. Decay momentum of $\mu^+ = 29{\cdot}80 \pm 0{\cdot}$ MeV/c. W. J. SWIATEC

539.

8701. Positive photomesons from hydrogen at N. JARMIE, G. W. REPP AND R. S. WHITE. Letter *Phys. Rev.*, **91**, 1023 (*Aug.* 15, 1953). A

The cross-section has been measured for 278 ± MeV γ-rays by magnetic deflection of the phot mesons out of the γ-ray beam. The result is plott together with data [Abstr. 1148 (1953)] for oth angles. No satisfactory theoretical interpretation yet available. J. J. WILKI

539.18

02. On the analysis of τ-meson data and the ure of the τ-meson. R. H. DALITZ. *Phil. Mag.*, 1068–80 (*Oct.*, 1953).

A convenient method of representation is proposed data on τ-meson decay configurations, applicable en the unlike outgoing π-meson is not distinguished. e relation between the spin and parity of the τ- son and the distribution of decay configurations obtained for some simple cases. The hypothesis t the τ- and χ-mesons are identical requires a n-zero spin for this particle and the available a on τ-meson decay does not exclude this possi- ty. However, observations in which the unlike going π-meson is not distinguished are relatively ffective in discriminating between the various ssibilities. The distortions which strong meson– son attraction may produce in τ-decay configura- s are discussed; the present data offers no evidence this effect. A.

539.18

03. The anomalous scattering of μ-mesons in lead. LEONTIC AND A. W. WOLFENDALE. *Phil. Mag.*, **44**, 01–12 (*Oct.*, 1953).

A multi-plate cloud chamber has been operated at -level under a thick lead absorber and the scatter- of penetrating particles—presumably μ-mesons— s been investigated. In common with the results other workers, a component of scattering has been nd which is not consistent with the distribution pected from simple Coulomb scattering from a cleus in which the charge is distributed uniformly oughout the volume ("solid" nucleus). It is found t the magnitude of this anomalous component is ilar to that expected from the Coulomb interaction th a nucleus of effective radius much smaller than t of the "solid" nucleus. Since it is very unlikely t the electrostatic charge of the nucleus can be nsidered to be concentrated at the centre of the cleus, it is concluded that the anomaly is probably e to a short-range non-electric interaction between nesons and nucleons. A.

539.18 : 537.591.1

The new unstable cosmic-ray particles. *See Abstr.* 38

539.185

04. Total cross-sections of the elements N, Na, Al d Si for 1·9–3·8 MeV neutrons. R. MEIER, R. CAMO, P. SCHERRER AND W. ZÜNTI. *Helv. phys. ta*, **26**, *No.* 5, 451–64 (1953) *In German.*

These were measured by transmission experiments the range 1·9 to 3·8 MeV. Monoenergetic neutrons obtained from the D–D reaction in a thin heavy- target with a spread in energy between 20 and KeV. Many new excited levels of N^{15}, Na^{24}, Al^{28} d Si^{29} are found. A level in N^{15}, excited with 25 MeV neutrons, has been analysed and is pro- sed to be a $J = 1/2$, odd-parity state. A.

539.185

05. Proof of the polarization of (*d*, *d*) neutrons ough scattering by carbon. E. BAUMGARTNER AND HUBER. *Helv. phys. Acta*, **26**, *No.* 5, 545–62 953).

The degree and direction of polarization of neutrons from the (*d*, *d*) reaction has been determined. The measurements were made with deuteron energies ranging from 250–900 keV. The neutrons, emitted by a thick D_2O target, were observed at an angle of 45° (laboratory system) with reference to the direction of the deuteron beam. The scattering of neutrons by carbon was used as an analyser. The change of degree of polarization is plotted as function of the deuteron energy. The results are compatible with theoretical estimations of the polarization effect, based on the Konopinski–Teller model of the (*d*, *d*) reaction, including tensor forces only. The degree of polarization observed at 600 keV deuteron energy amounts to $18 \pm 7\%$. The direction of polarization is perpendicular to the plane of reaction and forms a right-handed Cartesian system with the velocity of deuterons and neutrons. A.

539.185

8706. Neutron data needed for shielding and reactor design. H. GOLDSTEIN. *Nucleonics*, **11**, 39–43 (*July*, 1953).

The need for data on fast neutron processes (>10 keV), such as inelastic scattering, total and capture cross-sections, angular distributions of scattered neutrons, and energy spectra of neutrons and γ-radiation, is discussed. L. R. SHEPHERD

539.185

8707. A fast neutron coincidence spectrometer. P. R. CHAGNON, L. MADANSKY AND G. E. OWEN. *Rev. sci. Instrum.*, **24**, 656–60 (*Aug.*, 1953).

A fast neutron coincidence spectrometer of high efficiency has been constructed applicable to the approximate energy range of 1 MeV to 20 MeV. Design considerations and the working model are discussed. To illustrate the operation of such an instrument, the line spectra of the γ-rays from Co^{60} and of 3·3 MeV D–D neutrons are presented. Discrimination between γ-rays and neutrons is obtained by utilizing the difference in the time of flight of the two particles. In conclusion possible improvements are suggested. A.

539.185

8708. Slow-neutron scattering cross-sections of magnesium. P. A. EGELSTAFF AND R. JACKSON. *Nature* [*London*] **172**, 415 (*Aug.* 29, 1953).

The free-atom cross-section has been remeasured and found to be $3{\cdot}51 \pm 0{\cdot}09$ b. The bound-atom cross-section is therefore $3{\cdot}82 \pm 0{\cdot}10$ b, and nearly all of this is effective in neutron diffraction by magnesium or its compounds. J. M. CASSELS

539.185.08

8709. Continuous neutron detector for the measurement of densities in a pile. V. RAÏEVSKI AND M. PELLÉ. *J. Phys. Radium*, **14**, 463–4 (*July–Aug.–Sept.*, 1953) *In French.*

A copper strip is wound through the pile and past a Geiger counter, whose counting rate is recorded on a strip of paper. J. M. CASSELS

539.185.08 : 778.34

Nuclear emulsion techniques for the measurement of neutron energy spectra. *See Abstr.* 8171

STRUCTURE OF SOLIDS 539.2

539.213 : 666

8710. Thermodynamic and kinetic properties of glasses. R. O. DAVIES AND G. O. JONES. *Advances in Phys.*, **2**, 370–410 (*July*, 1953).

Review article with 80 references. Chief contents: early experiments on glasses; explanation of glass formation in terms of frozen structure; specific heat, expansivity and compressibility of the liquid and glassy states; experiments on the rate of approach to equilibrium; thermodynamic treatment in terms of an undefined "degree of order"; relations between glass properties and liquid properties; connections with bulk viscosity and ultrasonic absorption. The article is mainly concerned with stabilization and does not deal with flow properties. R. O. DAVIES

539.215.2

8711. The transition structure of the grain boundary observed in soap bubble raft. E. FUKUSHIMA AND A. OOKAWA. Note in *J. Phys. Soc. Japan*, **8**, 129–30 (*Jan.–Feb.*, 1953).

For values of θ (the angle between the crystallographic orientations of two adjacent grains) of less than $\sim 10°$ the boundary is composed of individual dislocation on parallel slip planes, and for larger θ, of disordered groups of atoms, illustrating respectively the grain boundary models proposed by Read and Shockley [Abstr. 7592 (1950)] and by Kê [Abstr. 2758 (1949)]. See also Abstr. 5344 (1952). A. D. LE CLAIRE

539.215.2

8712. On the dynamical behaviour of the grain boundary in bubble raft under shear stress. E. FUKUSHIMA AND A. OOKAWA. Note in *J. Phys. Soc. Japan*, **8**, 280–2 (*March–April*, 1953).

The behaviour of three types of grain boundary is illustrated: (1) High-angle boundary constituted of disordered groups of bubbles. Relative displacement of the adjoining grains occurs without change in position of the grain boundary; during the movement individual bubbles can be seen frequently changing their allegiance from the structure of one grain to that of another. (2) Low-angle boundary of an array of dislocations on parallel slip planes. The dislocations move in unison so as to change the position of the boundary in the manner envisaged by Read and Shockley [Abstr. 7592 (1950)]. (3) Low-angle boundary of dislocations on 2 or 3 sets of non-parallel slip planes. Here the behaviour is similar to (2) until pairs of dislocations on non-parallel slip planes approach to within a limiting distance, when further movement of the boundary is accompanied by changes in its dislocation structure. A. D. LE CLAIRE

539.216

8713. The structure of lustrous carbon layers. G. BECHERER. Note in *Naturwissenschaften*, **40**, *No.* 13, 362 (1953) *In German.*

Highly lustrous layers and grey layers have about the same mean crystallite size. There is a preferential orientation parallel to the layer plane, but the deviation is $\pm 30°$ for highly lustrous and $\pm 50°$ for the grey. This explains the difference in flaking thickness on cooling. C. TURNER

539.21

8714. Free interfacial energy and strain release brittle bodies. R. RAMSAUER. *Naturwissenschaft* **40**, *No.* 12, 336 (1953) *In German.*

Some marked differences are observed in glass under different loads in the presence of liqui These differences are illustrated by curves showing relations between the tensile strength and the cutt load for glass cut by a diamond in the presence certain polar and non-polar fluids and by pho micrographs of the cuts using interference a polarized light. These observations throw some li on the theoretical relations between the molecu tensile strengths and the free interfacial energy rived by Smekal. H. J. H. STA

539

8715. Structure of amorphous antimony. RICHTER AND G. BREITLING. Note in *Naturwiss schaften*, **40**, *No.* 13, 361–2 (1953) *In German.*

This is measured in evaporated and electroly (explosive) Sb. Layers are formed at a distance 3·85 Å, while in explosive Sb a mixture of amorph layers and crystalline Sb exists. C. TUR

539

8716. The behaviour of light-sensitive evapora layers in the electron microscope. H. HAARDI *Naturwissenschaften*, **40**, *No.* 14, 386 (1953) *In Germ*

A thin Ag film, evaporated on collodion is exami before and after conversion to AgBr and then dur irradiation in the electron microscope. The ini uniform distribution of single crystals of Ag is c verted to well separated (200 mμ) droplets of A which after irradiation have the appearance of hav exploded. The unit cell dimensions of the "bromi layer are intermediate between those of Ag and th of AgBr. The reason for this is still doubtful. also Abstr. 8804 (1953)]. J. THEW

539.

8717. On the structure loosening of metal films posited from the vapour. Y. FUJIKI AND R. SU NUMA. Note in *J. Phys. Soc. Japan*, **8**, 427–8 (*M June*, 1953).

The structure of thin Bi films loosens at a te perature θ which is a function of the film thickne and which $\simeq$ melting point when $t > 3\ \mu$. Mic scopic grain size had no effect on θ, but there wa correlation between t and the crystallographic pl which tended to lie parallel to the substrate. R tions between θ and t, similar to those observed w Bi, were also found with Sn. R. A. WE

539.234 : 541.

Sorption properties of thin nickel films. *See Ab* 8747

539

8718. The adaptation of the Norelco high-a spectrometer to the measurement of the X-ray diff tion of fibers. B. IRVIN AND F. B. BREAZEALE. *sci. Instrum.*, **24**, 627–31 (*Aug.*, 1953).

The use of the North American Philips spect meter for the radial and azimuthal scanning of transmitted X-ray diffraction of rayon tire yarns volved a change in the slit system from convergent divergent, design of a rotating sample holder reproducible sample preparation and positioning,

ibration and control checks which guarantee that X-ray intensity remain constant to ±2% as autotically recorded by the rate meter. Data are mpared with those obtained photographically. A.

539.27

19. Electron diffraction investigation of the actions aqueous heavy metal salts on mineral surfaces. Action of mercuric sulfate on galena cleavage face. SATO. *J. Phys. Soc. Japan*, **8**, 454–7 (*July–Aug.*, 53).

For Pt. I, see Abstr. 4470 (1953). The investigation the action of aqueous heavy metal salts on mineral faces was extended to mercuric sulphate/galena tem. Fresh cleavage face of galena was soaked in dic aqueous mercuric sulphate of low concentrations 30 min at room temperatures. The reaction oducts revealed by electron diffraction were: metanabarite (cubic HgS) in random and definite entation with respect to the substrate, and cinnabar exagonal HgS) in a certain epitaxial orientation. e pattern due to a roughened state of galena avage face was also observed. A.

539.27 : 771.37

Exposure meter for the electron microscope. Choice plate developers. *See Abstr.* 8830

LASTICITY . STRENGTH . RHEOLOGY
539.3/.8

539.31 : 548.7

On the determination of the elastic spectra of solids m specific heat data. *See Abstr.* 8772

539.313 : 551.16

20. Variation of the incompressibility of an elastic terial subjected to large hydrostatic pressure. KEANE. Letter in *Nature* [*London*] **172**, 117–18 ly 18, 1953).

Murnaghan's theory of finite deformation is used, gether with Bullen's compressibility pressure hypoesis, to estimate the compressibility at different oths in the earth's interior. J. G. OLDROYD

539.32

21. The evaluation of the elastic constants of rutile m spectroscopic data. B. DAYAL AND N. APPALARASIMHAM. *J. sci. Res. Banaras Hindu Univ.*, **1**, -30 (1950–51).

Using the force constants based on the Raman ect and the infrared data which were obtained by e of the authors in an earlier paper (1944), all the stic constants of rutile have been calculated. The mpressibility has been calculated and agrees well h the experimental values. A.

539.374

22. The release of the energy stored in deformed kel. L. M. CLAREBROUGH, M. E. HARGREAVES D G. W. WEST. Letter in *Phil. Mag.*, **44**, 913–15 g., 1953).

Certain possibilities suggested by previous work on [Abstr. 2767 (1953)] have now been tested by asuring the energy released in Ni, as the tempera- e increases, together with the changes in resistivity d hardness. About 40% of the energy stored in sional working is released between 200 and 300°c and is associated with the major decrease in resistivity. No hardness change occurs in this range. There is a gradual release of a further 20% up to about 550°c, when another sudden release occurs associated with a rapid decrease in the hardness. The lower temperature release is attributed to the disappearance of vacancies, and the higher temperature release to recrystallization. A. J. KENNEDY

539.374 : 539.26

8723. X-ray investigation of residual strains in plastically deformed iron. E. KAPPLER AND L. REIMER. Note in *Naturwissenschaften*, **40**, *No.* 13, 360 (1953) *In German.*

Measurements of the lattice constants of plastically deformed Fe show residual strains 7 or 8 times greater than those predicted by an extension of Greenough's theory [Abstr. 3692 (1947)]. The results do, however, support the theory, the numerical discrepancy being attributed to the hardening produced by the deformation. A. E. DE BARR

539.42

8724. Cleavage fracture of zinc single crystals. A. E. DERUYTTERE AND G. B. GREENOUGH. Letter in *Nature* [*London*] **172**, 170–1 (*July* 25, 1953).

Sohncke's law, that fracture occurs when N, the resolved component of stress normal to the most favourably oriented cleavage plane, exceeds a critical value, was examined for Zn using single crystals of 99·99% purity whose cleavage planes were variously oriented with respect to the direction of stress. A tensile testing machine was used to break these at −196°c. N was found to be far from constant, showing a regular variation with orientation. The interpretation of the results is complicated by the possibility that N is affected by the amount of plastic strain occurring before fracture, but it is clear that Sohncke's law is not always an adequate criterion for fracture. A. D. LE CLAIRE

539.434

8725. Interaction between crystal slip and grain boundary movement. D. MCLEAN. Letter in *Nature* [*London*] **172**, 300–1 (*Aug.* 15, 1953).

During the creep at elevated temperatures of aluminium samples the extent of the movement of the grain boundaries, in directions perpendicular to themselves, was found to increase rapidly with increase in the stress applied. This is to be expected if the boundaries move under the force of dislocations piled up against them, for the number of such dislocations and the force which each exerts on a boundary, both increase with the applied external stress.

A. D. LE CLAIRE

539.501

8726. The rheological curve. A. DE WAELE AND G. L. LEWIS. Letter in *Nature* [*London*] **172**, 298 (*Aug.* 15, 1953).

An empirical stress/rate-of-shear relationship is discussed. J. E. CAFFYN

539.61

8727. On the determination of adhesion tension and work of adhesion. E. LANDT. *Z. phys. Chem.*, **202**, 66–72 (*July*, 1953) *In German.*

The method of Bartell and Osterhof [*Z. phys. Chem.*, **130**, 715 (1927)] for determination of the adhesion tension of a powder is critically examined;

and the presence of an adsorbed film immediately in front of the advancing liquid in the pressure displacement cell is shown to necessitate a correction term (I). For complete wetting (contact angle $\theta = 0$) I can be calculated accurately if the specific surface is obtained by integration of the vapour adsorption isotherm, and approximately from heat of wetting data. For incomplete wetting θ must be known.

S. J. GREGG

539.

8728. On solid lubrication. M. R. FORTRAT. *He phys. Acta*, **26**, *No.* 3–4, 191–8 (1953) *In French.*

Static (μ_s) and dynamic (μ_d) coefficients of fricti measured for steel on steel, brass on steel and Al steel with solid lubricant layers of rosin, wax, graph and talc, at speeds up to 3 cm/sec and pressures fr 40 to 150 g/cm². With rosin and wax $\mu_s > \mu_d$, w graphite and talc $\mu_s < \mu_d$. J. W. MENT

PHYSICAL CHEMISTRY 541

PHASE EQUILIBRIUM . CHEMICAL REACTIONS 541.11/.12

541.123.5

8729. A modified isotopic exchange rate expression. R. E. JOHNSON. Letter in *J. chem. Phys.*, **21**, 1405–6 (*Aug.*, 1953).

A simple isotopic exchange reaction is considered under the assumption that the total amount of activity of the tracer remains constant. The usual rate expression is thereby modified by the inclusion of a term dependent upon the decay constant of the tracer isotope. This indicates that complete exchange is never attained, but that the rate of exchange into a given species is finally balanced by the exchange plus decay out of the species. Some reactions which may satisfy the conditions of the theory are suggested.

H. H. GREENWOOD

541.124

8730. The rate constant of the reaction between hydrogen peroxide and ferrous ions. W. TAYLOR AND J. WEISS. Letter in *J. chem. Phys.*, **21**, 1419–20 (*Aug.*, 1953).

The reaction has been followed by measuring the light absorption at $\lambda = 304\ m\mu$ of the ferric salt formed, whose molar extinction coefficient at this wavelength is much greater than that of hydrogen peroxide or ferrous ions. This procedure avoids both the introduction of foreign substances and the necessity of reaction quenching used in previous techniques. It is likely, therefore, that the results are more reliable. The values obtained for the rate constant measured over the range 15–40°C are significantly different from those obtained previously. H. H. GREENWOOD

541.124 : 535.33.07–15

8731. Application of a fast-scanning infrared spectrometer to gas-phase kinetic studies. G. R. COWAN, E. VINCENT AND B. CRAWFORD, JR. Letter in *J. Opt. Soc. Amer.*, **43**, 710–11 (*Aug.*, 1953).

The fast-scanning spectrometer [Abstr. 166 (1952)] has been modified by the incorporation of a standard Perkin–Elmer wavelength drive and power unit with lever arm linked through the mechanism for oscillating the Littrow mirror. Three types of operation are then possible, viz. fast scanning, intermediate (slower than 3 sec per scan) and slow (normal) scanning. The former uses d.c. detection, oscillograph presentation and photographic recording, and the last two modulated beam detection and chart recording. So details are given of the detector and recording unit

H. H. GREENWO

541.1

8732. Some new data on the NO–N_2O_5 reacti G. R. COWAN, D. ROTENBERG, A. DOWNIE, B. CRA FORD, JR, AND R. A. OGG, JR. Letter in *J. che Phys.*, **21**, 1397–8 (*Aug.*, 1953).

The reaction was studied by means of the f scanning infrared spectrometer (preceding abstra by following the absorption of N_2O_5 at 1730 cm^{-1} a NO_2 at 1630 cm^{-1} at a scanning rate of 4·3 c/s. T rate constants for the proposed mechanism are rived by a graphical method from the integrated r equation. Experimental details are given, and corrections for the formation of the strongly absorb N_2O_4 and the presence of HNO_3 are discussed. similar technique has been used to study the isoto exchange of N between NO_2 and N_2O_5.

H. H. GREENWO

541.1

8733. Application of a fast-scanning infrared spect meter to a kinetic study of the NO_2–C_2H_5OH reacti R. E. NIGHTINGALE, G. R. COWAN AND B. CRA FORD, JR. Letter in *J. chem. Phys.*, **21**, 1398–9 (*A* 1953).

See preceding abstracts. A preliminary study which the region 1600 cm^{-1} to 1800 cm^{-1} scanned during the course of the reaction. formation of C_2H_5ONO was established and the ti for completion of the reaction at different concent tions are given. Three rates of scanning were us 4·3 spectra per sec, one spectrum in 8 sec, and normal slow rate. H. H. GREENWO

541.

8734. The detonation of pentaerythritol tetranitr M. P. MURGAI. Letter in *J. chem. Phys.*, **21**, 140 (*Aug.*, 1953).

An application of the Lennard-Jones Devonsh theory of liquids as extended by Kirkwood to mu component fluid mixtures. The results obtained the temperatures and pressures attained at differ loading densities for the particular chosen values the parameters are compared with those given other authors. The differences are traced i vidually to the energy interaction terms which accounted for differently in the various metho The exponent of the adiabatic law is found to decre

th decrease in pressure in agreement with results tained previously. H. H. GREENWOOD

541.126

35. Size effects in the initiation and growth of plosion. F. P. BOWDEN AND K. SINGH; A. M. UILL. *Nature* [*London*] **172,** 378–80 (*Aug.* 29, 53).

Results are presented of experiments in initiating plosives by irradiating with electrons and neutrons, d by heating very small crystals. Explosion of PbN_6 crystals irradiated with electrons has been own to be due to bulk heating. Irradiation with w neutrons did not cause explosion in CdN_6, PbN_6, AgN_3, LiN_3 and Ag_2C_2; neither did the fission roducts of U^{235} cause the explosion of CdN_6 and PbN_6 crystals. Neutron irradiation produced colour anges and darkening in the crystals, reduced their duction period and increased the rate of decomposition. At a fixed temperature, crystals below a itical size (smallest dimension of the crystal) did ot explode, whereas larger crystals did. The critical ze decreases as the temperature rises; it is similar to e hot spot size measured in other ways. Smaller r insufficiently heated crystals of α-PbN_6 and AgN_3 lit and break up along crystallographic planes. uill's tests on the impact sensitivity of the single PbN_6 crystals show that the impact energy (for a 50% robability of explosion) increases rapidly as the ystal size decreases. For crystal heaps the impact ergy value is independent of the size of the individual crystals. F. LACHMAN

ELECTROCHEMISTRY 541.13

541.13 : 536.7

Thermodynamics of irreversible electrochemical henomena. *See Abstr.* 8386

541.132

736. Electrical conductivity of iodine-pyridine solutions. G. KORTÜM AND H. WILSKI. *Z. phys. Chem.*, **02,** 35–55 (*July*, 1953) *In German.*

Experimental details are given for the conductivity f solutions of iodine in pyridine with respect to oncentration and time. By means of an extrapolaon-method, the conductivity data may be divided nto two parts, viz., time-variable, which is traced o a reaction of iodine with the solvent; and time-onstant, which is due to the electrolytic dissociation f an iodine–pyridine complex compound as follows: $C_5H_5NI_2] \rightleftharpoons C_5H_5\overset{+}{N}I + \bar{I}$ (or $\bar{I}_3$). This treatment is upported by the observation that the vapour pressure f iodine over iodine–pyridine solutions is practically ero. Catalytic, optical and titrimetric data are ncluded to establish the course of the above reaction. H. H. HODGSON

541.135

737. Influence of ionic size and electron shell umber on the theory of strong electrolytes. H. ALKENHAGEN AND G. KELBG. *Z. phys. Chem.*, **202,** 6–65 (*July*, 1953) *In German.*

The results of the theory of the conductivity and of the dielectric constants of strong electrolytes already developed [Abstr. 2785 (1953)] are briefly summarized, and the potential dependence of the conductivity further investigated. Falkenhagen's theory [*Phys. Z.*, **32,** 353 (1931)] is used to determine the relaxation force and Wien's term for dependence on ionic radius. Since the Onsager motion of ions is neglected, the results are only qualitative, but calculation for the stationary case shows that the force of relaxation increases with increasing field strength, passes through a maximum, and falls. The dissymmetry of the ionic cloud cannot therefore develop continuously with increasing ionic velocities. H. H. HODGSON

541.135.62

8738. Magnitude of the Flade potential of activation and passivification of iron and other properties of the passive layer. K. J. VETTER. *Z. phys. Chem.*, **202,** 1–13 (*July*, 1953) *In German.*

The Flade potential [*Z. phys. Chem.*, **76,** 513 (1911)] of activation and passivification of iron has a more positive value than corresponds to the free enthalpy of the reaction, $FeO + H_2 \rightleftharpoons Fe + H_2O$. This follows from the unsaturated character of the oxide at the surface oxide/electrode with respect to dissolved iron brought about by corrosion, and in consequence it has a much higher O_2-partial pressure. The potential difference is explained as a diffusion potential on the Wagner and Mott–Cabrera theory of the oxidation of metals [*Z. phys. Chem. B,* **21,** 25 (1933)]. Notwithstanding the potential difference within the layer, it is shown that correct redox potentials must result. The proportion of ionic to electronic conductivity of the passive layer is estimated from resistance offered to d.c. and a.c. in redox system free electrolytes. The strong field causes iron ions to wander through the passive layer and replenish the loss caused by corrosion. H. H. HODGSON

PHOTOCHEMISTRY . RADIATION CHEMISTRY 541.14/.15

541.15

8739. Spatial distribution of free radicals formed during radiation-chemical processes. A. CHAPIRO. *C.R. Acad. Sci.* [*Paris*] **237,** 247–50 (*July* 20, 1953) *In French.*

In radiation-chemical processes the free radicals formed are initially located along the paths of the ionizing particles or photons. It is shown that the initial local concentrations of free radicals may be determined experimentally from observations of the effect of increasing the concentration of a solute capable of reacting with the radicals. At a sufficiently high concentration, the "critical concentration," all radicals should react with the solute and radical recombination should be suppressed. This "critical concentration" will also depend directly on the initial maximum concentration of radicals. Kinetic considerations are developed and specimen values deduced from published data. C. B. ALLSOPP

541.15

8740. The effect of pile radiation on polymethyl methacrylate ("Perspex"). I. M. Ross and A. Charlesby. *Atomics* [*London*] **4,** 189–94 (*Aug.*, 1953) Shorter version in *Nature* [*London*] **171,** 1153 (*June* 27, 1953).

Unlike many other long chain polymers, Perspex is broken up by high energy radiation in an atomic pile. Several of the changes produced are described, the most obvious being internal bubbling. The minimum radiation required for incipient bubbling depends on the temperature, e.g. 1·5–2 units at 70°c. Specimens exposed to shorter doses of radiation, although apparently unaffected, can be bubbled subsequently by heating. The suggested explanation of this phenomenon is the decomposition of the side chains of the polymer, liberating gases which, at a suitable temperature, can diffuse into bubbles. Polymer breakdown occurs when the internal gas pressure is sufficient to overcome the cohesive forces of the materials. Bubbles do not occur within a distance of 1 mm from the surface of the plastic. This is ascribed to the diffusion of the decomposition products to the surface, provided they are liberated sufficiently close to it. A hypothesis of this character was previously put forward to account for the weight changes in polyethylene [Abstr. 2789 (1953)] and is here confirmed visually in Perspex. The possibility of producing an expanded form of Perspex by radiation and subsequent heating is discussed. A.

541.15

8741. Production of iodine from solutions of potassium iodide irradiated with hard X-rays. E. R. Johnson. Letter in *J. chem. Phys.*, **21,** 1417–18 (*Aug.*, 1953).

The initial rate of production of I_2 from unbuffered KI solutions, 0·027–0·76 M, by 2 MeV X-rays is equivalent to the rate of H_2 formation from 10^{-3}–10^{-7} M KI solutions. The steady-state concentration of I_2 is increased by the addition of H_2 and by lowering the pH, but is decreased by addition of O_2 and I_2. The initial products of irradiation of iodide solutions are H_2 and I_2 with O_2 or H_2O_2 only appearing after the I_2 concentration has reached a critical level. C. B. Allsopp

541.15

8742. Formation of hydrogen peroxide in water by 1 MeV protons. R. J. Shalek and T. W. Bonner. Letter in *Nature* [*London*] **172,** 259 (*Aug.* 8, 1953).

At a dosage rate of $3·3\times10^{20}$ eV per cm^3 of water irradiated per sec, the production of H_2O_2 was linear with dose of protons (delivered from a 1 MeV Van de Graaff generator) up to a total input of 10^{19} eV; and at a rate of $3·5\times10^{18}$ eV/cm^3. sec it was linear at least to 5×10^{18} eV. The efficiency of H_2O_2 production decreases markedly as the dose rate is increased, and also when air is excluded at the lower dosage rates. C. B. Allsopp

541.15 : 539.16.08

8743. A differential dosimetry of pile radiations using Fe^{2+} oxidation. E. Saeland and L. Ehrenberg. *Acta chem. Scand.*, **6,** 1133–4 (1952).

It is shown experimentally that the yield of the reaction $Fe^{2+} \rightarrow Fe^{3+}$ occurring in irradiated solutions of $FeSO_4$ in 0·1 N H_2SO_4, is far greater f X- and γ-rays than for thermal neutrons, and th the relative chemical efficiencies of the differe kinds of radiation can easily be determined by th method. Experimental detail is to be published lat D. V. MAE

DISPERSIONS . COLLOIDS . ADSORPTIC 541.18

541.182.3 : 537.21 : 539.21

8744. An aerosol analyzer. J. I. Masters. *R sci. Instrum.*, **24,** 586–8 (*Aug.*, 1953).

Described is a simple device for measuring t total mass and total charge of a powder cloud. T instrument consists of a sensitive electrometer circ and a metallic collection chamber. The powder is co lected on a filter paper sealed between two aluminiu tubes which, if their lengths are three times grea than their diameter, provides sufficient shielding the charge collected on the filter paper to just assumption of an "Ice Pail." The shielding error less than 0·5%. A null-reading circuit is used with Cenco electrometer. The necessary counter volta for the null-reading circuit is supplied by a potent meter circuit, and a vacuum-tube voltmeter is used measure the voltage. Because it is desired to obta explicitly the mass and charge of a given cloud particles rather than the ratio of charge to ma enough mass must be collected for weighing and, addition, the total charge measured. This is to accomplished without disturbing appreciably t normal flow rate of powder from the aerosol generat

541.1

8745. The surface adsorption in solutions of sodiu dodecyl sulphate. R. Ruyssen and J. Maebe. *Med K. Vlaamse Acad. Wetensch.*, **15,** *No.* 4, 15 *pp.* (19 *In Flemish.*

Measurements of surface tension by the sta method, and of adsorption by the radioactivity of t surface active compound labelled by S^{35}, show go agreement with Gibbs' equation for solutions bel the micellar concentration range (2 mmol/l). definite and regular exponential increase of t adsorption up to 20 mmols/l does not agree w Gibbs' equation. It is suggested that only the tens active anions contribute to the surface tensi lowering, and that an electrical double layer is form by these anions and the positive counter-ions in t solution. C. TURN

541.1

8746. Study of the adsorption process in layers adsorbent with linear adsorption isotherms. C. Allander. *K. Tekn. Högsk. Avhandl, No.* 83 *Handl. No.* 70, 155 *pp.* (1953) *In German.*

The study was concerned with water as the adsorb and with dynamic conditions of adsorption, i.e. w a stream of carrier gas present. The process w studied first with one grain of adsorbent and th with thicker layers. The effect of the heat of adso tion is not negligible, and is taken into accou quantitatively with the aid of simplifying assumptio

d an equation is arrived at expressing adsorption a function of time; it involves an "adsorption efficient" which depends on the transport of heat, e grain size, diffusion within the adsorbent, the nperature and the partial pressure of the water pour. In columns of adsorbent, it is shown that e evolution of heat tends to give a flattening of the ont, and the conditions for a uniformly advancing ont are worked out. The effect of a size distribution hongst the grains of adsorbent is considered quantitively. Finally, an adsorption apparatus suitable r industrial testing of drying agents is described.

S. J. GREGG

541.183 : 539.234

47. Sorption properties of thin nickel films. . Scheuble. *Z. Phys.*, **135**, *No.* 2, 125–40 (1953) *German.*

An experimental and theoretical study of the rption of oxygen and hydrogen by evaporated films nickel. Details of the apparatus and methods are ven. The sorption of oxygen can be considered as o processes, (*a*) the surface of the metal film is st covered momentarily by a monatomic layer of ygen; (*b*) the oxygen atoms are then forced into e interior of the film. (*a*) is independent of the s pressure in the sorption apparatus. Hydrogen not so strongly absorbed by nickel but nickel hich has previously been exposed to oxygen behaves fferently towards hydrogen, the sorption now being ry much greater. Previous exposure of nickel films hydrogen does not influence the subsequent rption of oxygen.

J. IBALL

CHEMICAL STRUCTURE 541.2/.6

541.5

748. The valence frequency of NH in pyrrhole and nzopyrrholes. M.-L. Josien and N. Fuson. *C.R. cad. Sci.* [*Paris*] **236,** 1958–9 (*May* 18, 1953) *In rench.*

The spectra were taken of CCl_4 solutions. It is und that this frequency decreases with increase of e number of benzene nuclei in benzo-carbazoles. he frequency is not the same for isomers: substitution at 3·4 decreases more than at 2·3 and this uch more than at 1·2. In u.v. spectra 2·3 and 3·4 ibstitutions have similar effects, but 1·2 substitutes ow a different spectrum.

A. J. TAYLOR

541.57

749. Studies of the variations in bond dissociation nergies of aromatic compounds. I. Mono-bromo-yles. M. Ladacki and M. Szwarc. *Proc. Roy. oc. A*, **219,** 341–52 (*Sept.* 22, 1953).

541.57

750. Studies of the variations in bond dissociation nergies of aromatic compounds. II. Substituted romobenzenes. M. Szwarc and D. Williams. *roc Roy. Soc. A*, **219,** 353–66 (*Sept.* 22, 1953).

541.64

751. Comparison of equations of state for amorhous long-chain polymers. A. Charlesby. *Phil. Iag.*, **44,** 578–82 (*June*, 1953).

Rods of polyethylene, after annealing at 90°C, were irradiated with fast neutrons and γ-rays at 90°–100°C, thus producing a polymer by cross-linking which was substantially amorphous at room temperature. The specific volume-temperature curve of the material was investigated. The van der Waals equation is less satisfactory than the equation of state $(P + P_0(c))(v - v_0) = RT/M$ in representing the results. This equation assumes a constant internal pressure $P_0(c)$ for a given degree of cross-linking.

A. J. MEE

541.65 : 535.347–15

8752. Infra-red dichroism in synthetic polypeptides. A. Elliott. Letter in *Nature* [*London*] **172,** 359–60 (*Aug.* 22, 1953).

Experimental dichroic ratios for NH and CO vibration bands in nylon 66 are discussed in relation to the properties of other compounds.

G. F. LOTHIAN

LABORATORY APPARATUS 542.1/.7

542.41

8753. A variable temperature and humidity oven. J. N. Burcham. *J. sci. Instrum.*, **30,** 335–6 (*Sept.*, 1953).

Humidity control is achieved by saturating air with water vapour at a known temperature and then heating the saturated air to a higher temperature. The relative humidity is given by the ratio of the saturation vapour pressure of water at the lower and higher temperatures. The relative humidity may be set to any value between 30 and 95% over the temperature range 30 to 100°C.

A.

542.7

8754. Apparatus for automatically recording the absorption of oxygen. J. C. E. Button and A. J. Davies. *J. sci. Instrum.*, **30,** 307–10 (*Sept.*, 1953).

The apparatus records the mass of oxygen absorbed by a sample of material reacting slowly with a thermostatically controlled constant-volume oxygen atmosphere which is maintained at barometric pressure by replenishment with electrolytically generated oxygen. The electrolysis current is integrated electrolytically, producing a pressure proportional to the oxygen absorbed, which is recorded. The apparatus has no moving parts except those in the recorder and in a simple pressure-operated switch; it is particularly suitable for prolonged routine tests.

A.

CHEMICAL PROCESSES 542.9

542.9 : 537.525.5

8755. The reaction occurring in CO_2–H_2O mixtures in a high-frequency electric arc. K. A. Wilde, B. J. Zwolinski and R. B. Parlin. *Science*, **118,** 43–4 (*July* 10, 1953).

No reproducible occurrence of interesting reduction products could be found in experiments in which the flow rate varied from 5 to 35 cm^3/sec, the pressure from 50–200 mm Hg, the current 75–200 mA, the composition 3–25% H_2O by volume, the voltage

500–600 V; the gap distance was 5 mm, the frequency 3 Mc/s, and the electrodes were from Cu or Inconel.

F. LACHMAN

CHEMICAL ANALYSIS 543/545

545.33

8756. An indirect polarographic determination of calcium. B. BREYER AND J. MCPHILLIPS. Letter in *Nature* [*London*] **172,** 257 (*Aug.* 8, 1953).

Chloranilic acid is preferable to picrolinic acid in the indirect polarographic determination of calcium. In solutions neutral to Congo red the precipitation of Ca is complete within ten minutes. Ca is determined, without removing the precipitate, by adjusting the pH to 4·5, measuring the polarographic diffusion current of the residual chloranilic acid, and referring the value obtained to a calibration curve. The concentration range covered is $1{\cdot}3\times10^{-4}$ to $1{\cdot}2\times10^{-2}$ M with a maximum error of ±3%. Co, Pb, Zn, Mu, Cd, Ni, Al, Cu and Ag interfere. Fe^{III} and Hg^{II} should not be present in concentrations greater than $4{\cdot}8\times10^{-4}$ M and $5{\cdot}9\times10^{-4}$ M, respectively. The method is useful for determining Ca in biologic materials.

A. J. M

545.822 : 621.317.733 : 621.317.

8757. A symmetrical cathode follower bridge circ for direct spectrochemical analysis. W. G. WALK AND S. C. BAKER. *J. sci. Instrum.*, **30,** 328–30 (*Sep* 1953).

A d.c. circuit, efficient over a wide range of lig levels, has been developed for the comparison spectral line intensities. The potentials built across a pair of condensers due to the accumulat charges from two photomultiplier tubes exposed the lines are applied independently to the grids of t valves in a symmetrical two-stage cathode follow circuit. A null setting on an accurately wou potentiometer, as indicated by a short period galvan meter, both associated with the low impedance outp points of the cathode-followers, gives directly t ratio of these potentials and hence the line intens ratios. The circuit is virtually independent of supp potential variations and is free from drift. Compl compensation for phototube dark currents is provid

CRYSTALLOGRAPHY 548

548.0 : 537.228.1

Technique for testing the piezoelectric properties of crystals. *See Abstr.* 8393

548.0 : 537.529

Directional dielectric breakdown in single crystals. *See Abstr.* 8438

548.1

8758. Some observations on cadmium sulphide crystals. L. HERFORTH AND J. KRUMBIEGEL. Note in *Naturwissenschaften,* **40,** *No.* 9, 270–1 (1953) *In German.*

This note presents a macroscopic classification (by appearance) of 500 CdS crystals into five types and discusses some simple properties of these various types.

P. T. LANDSBERG

548.1 : 513.76 : 621.396.611.21

8759. The establishment of the orientation of crystal plates and the associated transformation of co-ordinates. R. BECHMANN. *Arch. elekt. Übertragung,* **7,** 305–7 (*June,* 1953) *In German.*

The two co-ordinate systems to be considered are that of the crystal axes and that of the plate cut from the original crystal. The orientation is defined by five symbols and the transformation of co-ordinates can be immediately determined from them. The first two symbols indicate two co-ordinates, e.g. thickness and length direction of the plate, while the last three give the required angles of rotation of the three axes when transforming from one co-ordinate system to the other. The necessary transformation matrices are provided.

H. G. M. SPRATT

548.1 : 519.4

8760. Enumeration of physical constants of crystals. A. RAHMAN. Note in *Acta Cryst.,* **6,** 426–7 (*May,* 1953).

The method of Bhagavantam and Suryanarayana [Abstr. 4256 (1949)] has been extended to cover t cases of infinite symmetry groups, as considered Jahn [Abstr. 4257 (1949)].

C. TURN

548

8761. The domain structure of lead titanate.. E. FESENKO. *Dokl. Akad. Nauk SSSR,* **88,** *No.* 5, 785 (1953) *In Russian.*

Polysynthetic twinning on (101) and (011) has be observed in crystals of $PbTiO_3$. Measured angles a in agreement with the tetragonal unit cell dimensic of $a = 3{\cdot}90$ Å, $c = 4{\cdot}147$ Å. Heating to 360–400 produced no change in the domain structure; abo that temperature, shrinking of the domains to place and at 500°C they disappeared. If the te perature of heating had not exceeded 500°C then t original pattern was re-established on coolin When cooled from above 500°C a new and genera simpler stable pattern appeared. The refractive inc at room temperature was 2·65.

A. L. MACK

548

8762. Some observations on the crystallography deformation twins. E. O. HALL. Note in *Acta cry* **6,** 570–1 (*June,* 1953).

A table is presented showing the crystallograp characteristics of the deformation twins of all t metals so far studied, together with notes commenti on the table and pointing out corrections to previou published work that it contains.

A. D. LE CLA

54

8763. Spiral growth of organic compounds from vapour phase. M. BRANDSTÄTTER. Note in *Nat wissenschaften,* **40,** *No.* 9, 272 (1953) *In German.*

Thirty-six substances for which growth spir have been observed are listed. In general the spi form is dependent on the degree of supersaturati

the vapour; the spirals are angular at low, and nd at high, temperatures respectively. S. WEINTROUB

548.5

4. Surface layer on crystalline quartz. O. S. AVENS. Note in *Acta cryst.*, **6**, 571–2 (*June*, 1953). An aluminium layer of mean thickness 0·9 Å iterates the Kikuchi lines almost completely. e amorphous surface layer on quartz can therefore be thicker than 1 or 2 molecules. C. TURNER

548.5

5. The martensitic transformation in cobalt. S. BASINSKI AND J. W. CHRISTIAN. Letter in *Phil. g.*, **44**, 791–2 (*July*, 1953).
ee also Abstr. 2755 (1953). A dislocation chanism is proposed for the growth of hexagonal-se-packed from face-centred-cubic Co, analogous that proposed by Thompson and Millard to cribe twinning in Cd [Abstr. 4729 (1952)].
A. D. LE CLAIRE

548.5

6. On the mutual transformation of lattices. A. BILBY. Letter in *Phil. Mag.*, **44**, 782–5 (*July*, 53).
An arrangement of three dislocation lines meeting a node on the interface between two lattices, with o of the dislocations lying on opposite sides of the erface, is defined as a "generating node between two lattices" if rotation about the node of the rd dislocation in the plane of the interface generates e lattice from the other. A mathematical dis-sion is given of the geometrical conditions to be isfied by generating nodes and of the method of nstructing them between given pairs of lattices. e theory is applied to the transformation of cobalt cussed in the preceding abstract. A. D. LE CLAIRE

548.5

7. A tentative theory of metallic whisker growth. D. ESHELBY. Letter in *Phys. Rev.*, **91**, 755 (*Aug.* 1, 53).
Size and growth rate of tin whiskers can be explained operation of a Frank–Read source beneath a all hump on the tin surface. J. W. MENTER

548.5 : 621.365.3/.4

8. Apparatus for crystal pulling in vacuum using graphite resistance furnace. K. LEHOVEC, J. SOLED, KOCH, A. MACDONALD AND C. STERNS. *Rev. sci. trum.*, **24**, 652–5 (*Aug.*, 1953).
A vacuum furnace is described for use in pulling ge single crystals of germanium from a melt. The ating element in this furnace is a resistance heated it graphite cylinder. A.

MOLECULAR AND X-RAY CRYSTALLOGRAPHY 548.7

548.7

9. Physical properties and atomic arrangements crystals. W. A. WOOSTER. *Rep. Progr. Phys.*, **16**, -82 (1953).
The properties discussed are the magnetic, optical, zoelectric and elastic. The well-established rela-ns between (*a*) diamagnetic anisotropy and molecular orientation and (*b*) paramagnetic anisotropy and the environment of complex ions are briefly reviewed. The more recent study of paramagnetic resonance absorption at high frequencies in a magnetic field is also included. The work on antiferromagnetic crystals is discussed in connection with the spinels. The study of optical activity and Raman spectra are considered under the heading of optical properties. The experimental confirmation by X-rays of the original convention concerning atomic configurations and the sign of optical activity in a molecule are described and also the connection between special features of the structures of tartrates, of sodium chlorate and of quartz and the handedness of the rotatory power is analysed. The piezoelectric properties of zinc blende, quartz, tourmaline, Rochelle salt and potassium dihydrogen phosphate are considered in relation to their structures. In the study of quartz and tourmaline the origin of the piezoelectric charge is attributed to tetrahedra of SiO_4 stressed in a direction from one corner to the opposite face. The spontaneous electric polarization of Rochelle salt and KH_2PO_4 is attributed to co-operative movements of hydrogen ions. Broad generalizations concerning the relation between elastic constants and the crystal structure are given. It is shown that the hardness increases in a regular way with the elastic constant c_{11} (or an average of c_{11}, c_{22}, c_{33}) and also that there is a close connection between directions of strong interatomic bonds and a large value of the corresponding elastic constant. 94 references. A.

548.7

8770. The influence of dipole moment on the type and properties of inorganic crystal lattices. H. KREBS. Note in *Naturwissenschaften*, **40**, *No.* 10, 291 (1953) *In German.*

548.7 : 539.11

Group theory and quantum mechanics of the structure of the transition metals. *See Abstr.* 8611

548.7

8771. Theory of the nuclear magnetic relaxation in crystalline solids. I. Direct process. T. MUTO AND M. WATANABE. *Progr. theor. Phys.*, **8**, 231–51 (*Aug.*, 1952).
This phenomenon has not yet been completely charified since both theories proposed by Bloembergen and Pound seem to be valid for special kinds of crystalline solids. A new mechanism of the nuclear magnetic relaxation in crystalline solids is presented in which the crystal electron plays an important role in the intermediate states of the second- or third-order transition processes. Such a mechanism for nuclear magnetic relaxation may be considered to be actually realized in all crystalline solids. The orders of magnitude for the nuclear magnetic relaxation times are found to be in good agreement with the available experimental observations in spite of this general theory being based upon the rather simplified model of Wilson for crystalline insulators. A.

548.7 : 539.31

8772. On the determination of the elastic spectra of solids from specific heat data. W. KROLL. *Progr. theor. Phys.*, **8**, 457–60 (*Oct.*, 1952).
A new method is proposed which allows the

frequency-distribution-function of solids to be expressed by real functions. The result can be written in such a way that it contains the experimental data in terms of a modified Debye temperature. A.

548.7

8773. Influence of volume changes and lattice vibrations in order–disorder transitions. L. SAROLÉA. *Physica*, **19**, 615–26 (*July*, 1953).

Introduces into the theory of order–disorder phenomena, two generally neglected effects: the variations of volume which accompany a change of temperature, and the vibration of the particles around their equilibrium position. In studying the influence of these effects on some characteristic properties of alloys it is found that: the position of the critical temperature is lowered; the nature of the singularity is not altered; the jump of the specific heat at the critical point is accentuated, this increase being of the same order as that obtained in using the combinatory factor of Bethe in place of that of Bragg and Williams. A.

548.7 : 538.632

Electronic Hall effect in NaCl. *See Abstr.* 8600

548.7 : 537.226.2

8774. Note on the relations between phase transitions, lattice defects, and Debye phenomena in solids. J. MEINNEL. Letter in *J. Phys. Radium*, **14**, 425 (*June*, 1953) *In French.*

It is pointed out that lattice defects often cause Debye dielectric relaxation effects and that phase transitions often lead to anomalies in the curves for the temperature variation of the real and imaginary parts of the dielectric constant. Examples of this generalization are given. C. A. HOGARTH

548.7

8775. Colour-centers of KCL–KBr mixed crystals in visible region. S.-I. KONDO AND M. MATSUMOTO. Note in *J. Phys. Soc. Japan*, **8**, 279 (*March–April*, 1953).

Absorption curves of X-ray coloured KCL–KBr mixed crystals are given and the wavelength of the *F*-band maximum is plotted against ionic distance. It is suggested that Br ions accumulate in the neighbourhood of a neg. ion vacancy. J. E. CAFFYN

548.7

8776. Colour centres in mixed alkali halide crystals. G. MIESSNER. *Z. Phys.*, **134**, *No.* 5, 576–81 (1953) *In German.*

Earlier results of Mollwo (1931) show that mixed crystals of KCl–RbCl, KBr–KCl and KBr and RbBr have a single *F*-band unrelated to those of the pure components. The present results confirm the earlier work and add data on the agreement between *F*-band position and the lattice constant of the mixed crystal. G. F. J. GARLICK

548.7

8777. Colour centres in fluorspar. F. LÜTY. *Z. Phys.*, **134**, *No.* 5, 596–603 (1953) *In German.*

Colour centres in natural and synthetic CaF_2 are considered equivalent to *F*-centres in alkali halides. By this assumption the results of different workers may be compared. G. F. J. GARLICK

54

8778. The position of the *V*-bands in mixed alk halide crystals. G. MIESSNER AND H. PICK. *Z. Ph* **134**, *No.* 5, 604–9 (1953) *In German.*

The position of the *V*-bands is studied in KCl–Rb and KCl–KBr mixed crystals at 20° and −183 The *V*-band differs in characteristics from the *F*-ba The position of the *V'*-band is dependent not on lat constants but on the anions of the lattice. G. F. J. GARL

548.7 : 537.533 : 535.

Field emission of crystal phosphors. *See Abstr.* 8

548.73/.74 : 539.26/

X-ray and electron investigation of materials. *Abstr.* 8718–19

548.

8779. Mechanical theory of the diffraction of p ticles by a [crystal] lattice. F. J. WIŚNIEWSKI. Le in *Nuovo Cimento*, **9**, 620–3 (*July*, 1952) *In French*

A previous derivation [Abstr. 4015 (1952)] fro corpuscular viewpoint of the Laue conditions diffraction from a crystal whose atoms are at rest extended to the case of crystals suffering forced thermal vibrations, and leads to relations for broadening of diffracted beams which results fr such movement. The theory is applied to phot and to both classical and relativistic particles. A. D. LE CLA

548.

8780. Influence of mosaicity on the Bragg reflex of polarized X-rays. S. RAMASESHAN AND G. RAMACHANDRAN. *Acta cryst.*, **6**, 364–5 (*April*, 19

For polarized X-rays the integrated reflection c crystal varies with the azimuth of polarization different ways for mosaic and perfect crystals. effect is investigated for sodium nitrate crystals us an almost completely polarized beam, and it is sho that it can be used to assess the degree of perfect of a crystal. J. THEW

548.

8781. Reference data for orienting quartz plates X-ray diffraction. C. BARCLAY AND L. T. So *Circ. Nat. Bur. Stand., No.* 543, 7 *pp.* (1953).

The relative intensities of X-rays reflected fr large number of planes in quartz were measured. results of these experiments are given with suggesti for their most effective use in the determinatio orientation of crystal blanks. Graphs are presen which indicate the effect of inclined planes on the tensities of the reflected beam as well as the z position of the Bragg angle reading. Tables charts to facilitate the use of the most essential X- data are included. Other information of use to technician in checking the orientation of crystal cut presented.

548.

8782. The interpretation of X-ray powder pho graphs of crystals of low symmetry. J. THEWLIS A T. S. HUTCHISON. *Acta cryst.*, **6**, 357–8 (*April*, 19

A method is described for indexing powder pho graphs of crystals of low symmetry. An arbitr triclinic unit cell is found which, by means o stereographic projection, leads to the Laue symme

he true unit cell. The unit cell itself can then be id. The method, which does not demand unduly t accuracy of spacing measurement, is applied success to α–U but fails in the case of β–U, pre-ably owing to the large unit cell. J. THEWLIS

548.735

3. A remark on some new methods of phase rminations. J. KROGH-MOE. Note in *Acta cryst.*, 58–9 (*June*, 1953).

nows how some of the methods developed by insky and Cochan (1951) can be related to the nerjee equations (1933). C. TURNER

548.735

4. A discussion of the Cox and Shaw factor for que incidence and the film-to-film factor in mul-e-film exposures. M. M. QURASHI. *Acta cryst*, **6**, -9 (1953).

he effects produced by an X-ray beam incident quely on a photographic film were discussed by and Shaw (1930) who, however, used an erro-us expression for the transmission by the emulsion also ignored the non-linearity of the curve of sity against X-ray exposure. The consequences his are discussed and an expression is proposed use with visually estimated intensities. Finally an ression is given for the intensity factor from one to the next in a multiple-film stack at oblique dence. J. THEWLIS

548.735

5. The Fourier transform of a coiled-coil. H. C. CRICK. *Acta cryst.*, **6**, 685–9 (*Sept.*, 1953).

he Fourier transforms are given for a continuous ed-coil, and for a set of atoms spaced at regular rvals along a coiled-coil. The nature of the solu-n is briefly discussed. See also abstract following. A.

548.735

6. The packing of α-helices: simple coiled-coils. H. C. CRICK. *Acta cryst.*, **6**, 689–97 (*Sept.*, 1953).

t is shown that when α-helices of the same sense k together they will probably do so about 20° ly from parallel. For very long chains this may l to a coiled-coil. The two simplest models—the -strand rope and the three-strand rope—are de-bed, and used to illustrate the diffraction theory ady developed. It is shown that they would give diffuse α-pattern. Possible examples of these dels are briefly discussed. See also preceding tract. A.

548.735

7. A simple but versatile strip technique for calcu-ng structure factors. L. ALEXANDER. *Acta cryst.*, 27–31 (*Sept.*, 1953).

wo new sets of strips especially designed for the id calculation of structure factors are described. smaller set, consisting of but 150 basic strips, uires that the parameters be expressed with two-ce accuracy, as in the earlier stages of a structure lysis. The second set consists of 1500 basic strips provides for the calculation of exact structure ors for parameters accurate to 0·001. These new ps overcome several weaknesses inherent in the lication of Beevers–Lipson 3° Fourier strips to structure-factor calculations. Either set permits the calculation of structure factors involving terms of the important product type, $\sin 2\pi hx \cdot \sin 2\pi ky$, etc., at the rate of 20–25 per hour in typical cases. A.

548.735

8788. The meaning of the average of $|F|^2$ for large values of the interplanar spacing. D. HARKER. *Acta cryst.*, **6**, 731–6 (*Sept.*, 1953).

It is shown that A. J. C. Wilson's equation (1942), $\langle I \rangle = \Sigma f^2$, is valid only if $d(hkl)$ is smaller than the smallest interatomic distance in the crystal. The correct equation for $\langle I \rangle$ for use at large d's is derived. It is shown that the equation, $\langle I \rangle = \Sigma F_g^2$, where F_g is the scattering power of a glob of atoms, is nearly correct for d's larger than twice the shortest interatomic distance and smaller than the shortest distance between centres of globs. This last statement is most nearly true for globs that consist of "spherical tops of scattering matter," i.e. whose second moment of scattering is the same for all directions. A.

548.735.44

8789. Three-dimensional Fourier summations on a high-speed digital computer. S. W. MAYER AND K. N. TRUEBLOOD. Note in *Acta cryst.*, **6**, 427 (*May*, 1953).

In most cases not more than 90 minutes is needed for summation over the unit cell. C. TURNER

548.735.44

8790. A contribution to the determination of signs in the Fourier analysis of crystals. O. A. TESCHE. Note in *Acta cryst.*, **6**, 564 (*June*, 1953).

If symmetry or packing indicate a uniform electron density over certain planes, there are simple relations between some Fourier coefficients from which the signs can be found, if the absolute values are known. C. TURNER

548.735.44

8791. The comparison of theoretical and experimental determinations of molecular structures, with applications to naphthalene and anthracene. D. W. J. CRUICKSHANK AND A. P. ROBERTSON. *Acta cryst.*, **6**, 698–705 (*Sept.*, 1953).

An earlier discussion [Abstr. 5133 (1949)] of the use of statistical significance tests in the comparison of experimental and theoretical determinations of molecular structures is extended, and the application of multivariate tests is shown. The accuracy of atomic co-ordinates determined by Fourier or least-squares methods, irrespective of whether the peaks overlap or not, is discussed in detail. Formulae are given for the errors of molecular parameters in terms of the errors of the atomic parameters of the crystal structure. The methods are applied in a discussion of the latest results on naphthalene and anthracene, and it is shown that while it is hardly necessary to postulate any errors in the molecular-orbital theory for anthracene, there are very significant discrepancies for naphthalene. A.

548.735.44

8792. Electron-density errors at special positions. D. W. J. CRUICKSHANK AND J. S. ROLLETT. *Acta cryst.*, **6**, 705–7 (*Sept.*, 1953).

Approximate formulae are given for the electron-density and slope errors at special positions in any

space group. An example shows that the errors at special positions can be several times those at general positions. A.

548.735.46

8793. The double Patterson function. D. SAYRE. Note in *Acta cryst.*, **6**, 430–1 (*May*, 1953).

This is $DP(x, y) = \int dt d(t + x) d(t + y) dv$, which can be calculated approximately from the data and can be used in work on the phase problem. C. TURNER

548.736.3

8794. X-ray evidence for the interstitial position of carbon in α iron. G. K. WILLIAMSON AND R. E. SMALLMAN. *Acta cryst.*, **6**, 361–2 (*April*, 1953).

The two types of interstitial sites available for C in αFe lead to distortions of the iron lattice with different degrees of symmetry. Geiger-counter measurements of line breadths in αFe lead to the conclusion that at least 80% of the C atoms occupy octahedral interstices. A. E. DE BARR

548.736.3

8795. Metallic carbides and nitrides of the type MX. W. HUME-ROTHERY. *Phil. Mag.*, **44**, 1154–60 (*Oct.*, 1953).

The structures of the metallic carbides and nitrides of the type MX with the sodium chloride structure are discussed. The view that this structure is formed in order to provide the non-metallic atom with an octahedral interstice is shown to be improbable or only part of the truth and it is considered that the face-centred cubic arrangement with the metal atoms is favoured mainly because it provides the metallic atoms with mutually perpendicular bonds to six neighbours. The melting points are discussed, and the need for further work on the electrical properties of these compounds is emphasized. A.

548.736.3 : 536.631 : 537.311.32

8796. Thermal and electrical properties and crystal structure of tungsten oxide at high temperatures. S. SAWADA. Letter in *Phys. Rev.*, **91**, 1010 (*Aug.* 15, 1953).

The sp.ht and d.c. resistance ρ were measured at temperatures T between 600 and 1050°C. Two anomalous peaks in the sp.ht $\sim T$ curve were observed of about 0·05 and 0·03 cal/g/°C at 730 and at 900°C respectively. In the $\rho \sim T$ curve there occurred a slight maximum near 890°C and a break at 720°C. X-ray measurements showed a slight increase near 710°C of both the a and c lattice parameters. See also Abstr. 1708, 4022 (1952). A. D. LE CLAIRE

548.736.6

8797. The crystal structure of milarite. Z. P. PASHEVA AND T. N. TARKHOVA. *Dokl. Akad. Nauk SSSR*, **88**, *No.* 5, 807–10 (1953) *In Russian.*

Slight corrections are made to the parameters of milarite which were determined by Belov and Tarkhova [*Dokl. Akad. Nauk SSSR*, **69**, *No.* 3, 365–8 (1949) and *Trudy Inst. Krist. Akad. Nauk SSSR*, *No.* 6, 83–140 (1951)]. Both sets are in close agreement with parameters found by Ito, Morimoto and Sadanaga [*Acta cryst.*, **5**, *No.* 2, 209–13 (1952)] when the latter are transformed to new axes. It is pointed out that the Japanese authors should have known from abstracts of the earlier work. Japanese interpretation of the crystal chemistry milarite is not accepted. A. L. MAC

548

8798. Low-temperature investigations of the st tures of aromatic compounds. I. Anisotropy of thermal expansion of naphthalene. V. M. KOZ AND A. I. KITAĬGORODSKIĬ. *Zh. fiz. Khim.*, **27**, *No* 534–41 (1953) *In Russian.*

Weissenberg (?) photographs were taken of crys of naphthalene enclosed in cellophane envelope room temperature and at −195°C (liquid N). F of high and low temperature photographs were ta on each film. At 20°C the unit cell dimensions found to be $a = 8{\cdot}218 \pm 0{\cdot}005$, $b = 5{\cdot}990 \pm 0{\cdot}$ $c = 8{\cdot}640 \pm 0{\cdot}0005$ kX, $\beta = 122°55' \pm 10'$ and −195°C, $a = 8{\cdot}108 \pm 0{\cdot}005$, $b = 5{\cdot}938 \pm 0{\cdot}$ $c = 8{\cdot}6188 \pm 0{\cdot}0005$ kX, $\beta = 124°40' \pm 10'$. gives for the mean value of the principal coefficient expansion over this range $\alpha_{11} = (212{\cdot}8 \pm 4{\cdot}0) \times 1$ $\alpha_{22} = (40{\cdot}3 \pm 0{\cdot}4) \times 10^{-6}$ and $\alpha_{33} = (6{\cdot}15 \pm 0{\cdot}1) \times 1$ α_{22} coincides with the crystallographic b axis and makes an angle of 44·0° ± 10′ with the a axis. mean values of the coefficients of expansion along axes of the molecule in the crystal are, $\alpha_L = 22{\cdot}$ 10^{-6}, $\alpha_M = 80{\cdot}5 \times 10^{-6}$, $\alpha_N = 143{\cdot}7 \times 10^{-6}$, wh L and M are the larger and smaller axes of the m cule and N is the normal to the plane of the molec A. L. MAC

548

8799. The crystal structure of metallo-orga compounds. III. X-ray investigation of the cry structure of tetrà-para-tolyl tin, $Sn(C_6H_4CH_3)_4$. I ISMAILZADE AND G. S. ZHDANOV. *Zh. fiz. Khim.*, *No.* 4, 550–3 (1953) *In Russian.*

Unit cell, *idem ibid.*, **24**, 1945 (1950). The atom at the origin contributes to all reflect enabling an *hk*0 Fourier projection to be constru directly. All C atoms were resolved giving a struc very close to that expected from packing considerat and by analogy with $Sn(C_6H_5)_4$. The space grou $I\bar{4}$ and ϕ, the angle of rotation of the molecule in *hk*0 projection from coincidence with the x a was found to be 14°30′ ± 1°, and ψ, the angle rotation of each phenyl group about its bond with Sn atom from planes parallel to the z axis, measured as 44° ± 2°. Free rotation of the me groups is thought to take place. Some deforma of the benzene ring occurs. A. L. MAC

548

8800. The structure of oxamide. C. ROMERS. in *Acta cryst.*, **6**, 429 (*May*, 1953).

Dimensions, parameters and atomic distances given. The molecules are flat and form a l structure similar to the cyanuric acid structure. C. TUR

548

8801. Proposed polypeptide chain configurat and the structure of horse hemoglobin. D. WRI *Acta cryst.*, **6**, 562–4 (*June*, 1953).

The vector maps of normal wet monoclinic h methaemoglobin obtained by Perutz (1949) re-examined, especially the high vector density

ox. 5 Å from the origin. The conclusion is ned that this "5 Å shell" cannot be interpreted rms of a 5 Å repeat along a set of parallel rod-like peptide chains in any direction, no matter how atomic configurations of the chains are chosen. question as to whether such rod-like polypeptide ns do in fact exist at all in horse haemoglobin is e discussed in a further paper. J. IBALL

548.737

. The hypothesis of parallel rod-like polypeptide ns in horse hemoglobin. D. WRINCH. *Acta cryst.*, 8–46 (*July*, 1953).

udies Perutz's hypothesis and the Bragg–Howells– tz [Abstr. 4784 (1952)] and similar structures he light of all the published vector maps of the noclinic horse methaemoglobin hydrates, including three-dimensional vector map for crystal No. 5. concluded that the vector rods claimed by Perutz not, in fact, exist. It is further concluded that e are, in these vector maps, indications that the e haemoglobin entity does not have the Bragg–vells–Perutz structure or, indeed, any structure comprising a set of parallel rod-like polypeptide chains. A.

548.74

8803. Structure of selenium tetrafluoride. H. J. M. BOWEN. Letter in *Nature* [*London*] **172,** 171 (*July* 25, 1953).

Electron diffraction maxima were in agreement with a structure in which the fluorine atoms form distorted tetrahedra around the selenium atoms. A. R. STOKES

548.74

8804. On the determination of the lattice constants of some cubic crystals by electron diffraction. S. K. MAJUMDAR. *Naturwissenschaften*, **40,** *No.* 13, 352 (1953) *In German.*

The unit cell dimensions of Au, Cu, Ag, AgCl, AgBr, NaCl and KCl, as determined by electron diffraction in a Siemens electron microscope are compared with those determined by X-rays. There are discrepancies in every instance of a few per cent, except in the case of AgBr where the discrepancy is 16%. [See also Abstr. 8716 (1953).] J. THEWLIS

GEOPHYSICS 55

550.311

5. On density and compressibility at pressures to thirty million atmospheres. K. E. BULLEN. *nthly Not. Roy. Astron. Soc., Geophys. Suppl.*, **6,** -401 (*Sept.*, 1952).

he density and compressibility tables at very high ssures given by Elsasser [Abstr. 4810 (1951)] are sed after a critical examination. These new cal- tions lead to an atomic number in region E of central core of the earth not greater than 28 and sibly lower, so that its constitution is probably kel–iron but may be silicates. The uncertainties hese deductions are emphasized. G. J. KYNCH

550.837/.838

6. Principle of the magneto-telluric method, a geophysical prospecting method. L. CAGNIARD. *. Géophys.*, **9,** 96–125 (*April–June*, 1953) *In French.*

or a given subsoil at a given spot, quantitative tions may be established between the horizontal nponents of the electric field and the magnetic 1 when any sort of telluric current is flowing in subsoil. From them the electrical resistivity and thickness of the subjacent geologic strata may be uced. The new method seems to offer the follow- advantages: speed, low cost, unlimited depth of estigation, and easy quantitative interpretation. A.

551.16

7. The earth's inner core. J. A. JACOBS. ter in *Nature* [*London*] **172,** 297–8 (*Aug.* 15, 1953)

ssuming the core to consist mainly of iron and mantle of silicates, a melting-point curve is con- ucted and analysed. It is suggested that the solidi- tion began at the centre of the earth, and not at boundary of the core and the mantle (as it is at sent supposed), giving physical reasons for the tence of a solid inner core. A. BEER

551.311.124

8808. The flow law of ice from measurements in glacier tunnels, laboratory experiments and the Jungfraufirn borehole experiment. J. F. NYE. *Proc. Roy. Soc. A*, **219,** 477–89 (*Oct.* 7, 1953).

The paper attempts to relate four recent sets of measurements on the flow laws of ice: (1) Glen's laboratory compression tests (1952); (2) Gerrard, Perutz and Roch's pipe experiment on the Jungfraufirn [Abstr. 7739 (1952)]; (3) measurements of contraction rate in a tunnel in Skauthöe Glacier by McCall (1952); and (4) measurements of contraction rate in tunnels in the Z'Mutt and Arolla Glaciers reported by Haefeli and Kasser (1951). When they are analysed within the framework of a general flow theory, satisfactory agreement is found between all these results, with one exception: the reported rate of collapse of the Arolla tunnel is faster than would be given by the present theory. The paper includes the theory of the slow collapse of a cylindrical or a spherical hole in a medium showing non-Newtonian viscosity. A.

ATMOSPHERE . METEOROLOGY 551.5

551.5 : 612.014.481

8809. 'Weather perception'—a solar effect. U. KÖHLER. Letter in *Naturwissenschaften*, **40,** *No.* 13, 360–1 (1953) *In German.*

It is suggested that the biological reactions in certain individuals known to be pre-sensitive to weather-changes are triggered by solar radiation responsible for the "Mogel–Dellinger" effect in s.w. radio transmissions. In support of the idea, an

example is cited of a high degree of correspondence between the received strength of 25 m transatlantic radio signals, 22h to 23h U.T. daily, and the intensity of pain felt by a subject suffering from chronic rheumatoid-arthritis observed from 10 Dec., 1952, to 31 March, 1953. D. R. BARBER

551.508.11

8810. A method for obtaining long exposures at high altitudes using rubber balloons. V. D. HOPPER AND A. R. W. WILSON. Note in *J. sci. Instrum.*, **30**, 211–12 (*June*, 1953).

A 2000 g rubber balloon has a valve head connected to a cork tied into the balloon rubber diametrically opposite to the neck. The valve head moves freely in a valve tube and is held in the closed position in flight by its own weight until the balloon diameter exceeds the length of the string. The string length is adjusted initially to the balloon diameter for zero lift at the desired height. In practice, due to balloon oscillations and the limited outlet speed of the valve, there is a small negative lift after the valve closes and the balloon descends slowly. Results of three flights are given. Balloons can thus be followed from a fixed base for several hours while the distance between release and landing points remains comparatively short. R. S. READ

551.510.535

8811. Reflexions from irregularities in the ionosphere. G. H. MUNRO. *Proc. Roy. Soc. A*, **219**, 447–63 (*Oct.* 7, 1953).

As part of the investigation of travelling disturbances in the ionosphere during four years, a close study has been made of small daytime changes in the virtual height of *F* region reflections with periods of 10 min to 1 hr. In some cases, complex reflections are observed. It is shown that although three distinct types of complexity may be recognized, they can all be explained simply as reflections from a curved surface of the type associated with travelling disturbances, the diversity of type resulting from differing group retardations in the different paths. A.

551.510.535

8812. Travelling disturbances in the ionosphere. R. E. PRICE. Letter in *Nature* [*London*] **172**, 115–16 (*July* 18, 1953).

Simultaneous recording of *F*2 echoes on 5·8 Mc/s from 3 transmitters situated respectively at, 15 miles E., and 25 miles S.E. of the base station reveal time differences for changes of the reflecting layer from which the velocity and direction of the disturbances can be determined. Results indicate speeds of 5–20 km/min, with a sharp changeover of direction in equinoctial months. G. M. BROWN

551.510.535 : 537.591 : 523.72

8813. On the longitude effect of a corpuscular stream from the sun. G. ISHIKAWA. *J. Geomagn. Geoelect.*, **2**, *No.* 3, 74–6 (1950).

It is suggested that the diurnal variation of ionization in the *F* layer may be due to corpuscular streams from the sun. Deflection of the charged particles in such streams by the earth's magnetic field is considered and it is pointed out that the asymmetry and double maximum of the diurnal variation could be accounted for by a suitable choice of density momentum spectrum for particles in the stream. H. EL

551.510.535 : 538.5

Radio-wave propagation in the ionosphere. *Abstr.* 8595–6

551.510.535 : 621.39

8814. Radio echoes observed during aurorae terrestrial magnetic storms using 35 and 74 Mc/s w simultaneously. L. HARANG AND B. LANDMA Letter in *Nature* [*London*] **171**, 1017–18 (*June* 6, 19

Close study of the characteristics of simultane radio echoes on 35 and 74 Mc/s received near and at Tromsö leads to the conclusion that the ec are produced by reflection of backwards scatter f land or sea via the E_s-layer (the ionization of w increases strongly during auroral activity), ra than by primary scatter from the auroral form inhomogeneities in the ionosphere. G. M. BR

551.513 : 538.5

Oceanic duct and its effect on microwave propa tion. *See Abstr.* 8592

551.593 : 53

The atmospheric light and its influence on colou the landscape. *See Abstr.* 8350

551.593.7 : 5

8815. Polarization of light from the sky. H. N SEN. Letter in *Naturwissenschaften*, **40**, *No.* 13, (1953) *In German.*

Wohlisch's method of dealing with light from sky by use of a mirror is considered faulty bec each reflecting surface oblique to the rays changes polarization of the light. A method is given by w a double, refracting mica plate producing a difference of $\lambda/2$ is employed to change the directio oscillation. A further simplification allows direction and degree of polarization to be determi by using a polarization filter with two pieces rot 90° compared with one another. If fitted wit graduated circle an exact measurement of the de of polarization is possible. R. S. R

551.594

8816. Thunderstorms in Central Asia. M. GLEĬZER. *Elekt. Stantsii*, **1953**, *No.* 5, 42–4. *In Russ.*

The results of long-term observations of lightn flashes in Central Asia show that the frequency occurrence and, to some degree, the intensity of flashes increase with the altitude. The frequency occurrence depends also on the longitude, increa from west to east. The number of thunderstorm in a year varies from 5 to 40 for different regions, for the most of the country is between 10 and The thunderstorm seasons are spring and autu A short survey is included of the outages damage caused by lightning in the last six years various 35 and 110 kV transmission lines. E. M. DEMBIN

551.5

8817. The aurorae. V. C. A. FERRARO. *Advan in Phys.*, **2**, 265–320 (*July*, 1953).

A descriptive account of the phenomena obser in the N- and S-auroral zones, and of the vari theories put forward to explain them. Partic attention is given to those theories, e.g. Alfve based on the conception of a neutral ionized s

puscular stream, which appear to be most nising in the light of recent research. D. R. BARBER

551.594.5

3. Some remarks on spectra of low-intensity ras. N. J. OLIVER, S. J. WOLNIK, J. C. SCANLON J. W. CHAMBERLAIN. Letter in *J. Opt. Soc. er.*, **43**, 710 (*Aug.*, 1953).

summary of 150 line- and band-emission features ntified in auroral spectra photographed in Alaska, 2–53, with an f 0·8 grating-spectrograph, range, 0–8850 Å and 1st order dispersion, 130 Å/mm. ides the auroral features, the spectra include air- v Na D lines; and O_2, OH bands in infrared. D. R. BARBER

551.594.6 : 621.3.018.7 : 621.396.821

8819. The variation with distance in the range 0–100 km of atmospheric wave-forms. R. B. MORRISON. *Phil. Mag.*, **44**, 980–6 (*Sept.*, 1953).

The magnitude and waveform of atmospherics within 100 km of the source have been calculated on the basis of existing information on the lightning discharge. Particular attention is paid to the variation with distance of the waveform associated with the return stroke. This variation shows several characteristics of interest. A direct comparison is made between the theoretical results and the experimental observations made on near atmospheric waveforms. A.

BIOLOGY 57/59

578.08

0. An electrical analog for analysis of compartital biological systems. G. L. BROWNELL, R. V. VICCHI AND K. E. PERRY. *Rev. sci. Instrum.*, **24**, –10 (*Aug.*, 1953).

iological models may be simulated by an elecal network, and voltage curves from five of the compartments may be observed simultaneously the face of an oscilloscope. These voltage curves r a scale relationship to the specific activity curves the biological model. Applications and theory discussed. A.

591.112 : 591.08

1. An improved cuvette densitometer for cardiac ut determination by the dye-dilution method. R. GILFORD, D. E. GREGG, O. W. SHADLE, T. B. GUSON AND L. A. MARZETTA. *Rev. sci. Instrum.*, 696–702 (*Aug.*, 1953).

n this method the output is calculated from the tionship expressing rate of dilution of a dye introed in the heart as a function of flow rate. The of the densitometer is that of recording the timecentration function of the dye in blood. This ording is made as whole blood is led in a continuous v from a peripheral artery of the subject through transparent cuvette of the densitometer. The sitometer is an improvement over previous units its stability, sensitivity, size and convenience of lication. A complete description of the principles peration, circuit details, mechanical arrangement l performance characteristics is included along with mmendations for future improvements. A.

591.121.08

2. A sensitive respirometer for the measurement rapid changes in metabolism of oxygen. C. M. NNELLY, D. W. BRONK AND F. BRINK, JR. *Rev. sci. rum.*, **24**, 683–95 (*Aug.*, 1953).

The respirometer consists essentially of the nerve ak itself, placed symmetrically across the tip of a arized platinum microelectrode which is flush with floor of the chamber. The sides of the nerve are osed to moist gas of known oxygen content; the surface of the nerve is covered. The current to platinum electrode measures the concentration of oxygen in the nerve at the electrode tip. In the steady state the oxygen concentration near the electrode is determined by: (1) the configuration of the system, (2) the oxygen content of the gas phase, (3) the diffusion coefficient of oxygen in the tissue and, (4) the rate of oxygen consumption by the tissue. Starting from the steady state, any change in rate of oxygen uptake may be followed directly during the first 45 to 60 sec of such a change; during this time the change is equal to the negative of the rate of change of oxygen concentration at the electrode tip. Slow, prolonged changes in respiratory rate may be followed, within limitations determined by the diffusion characteristics of the system and by slow drift in electrode calibration. It is estimated that changes in rate of oxygen uptake as small as 0·3 mm^3 O_2/cm^3. hr (0·6% of the rate of uptake by resting frog nerve) can be reproducibly detected. A.

591.481.1 : 591.08

8823. A micro glass electrode for continuous recording of brain pH, *in situ*. R. R. SONNENSCHEIN, R. M. WALKER AND S. N. STEIN. *Rev. sci. Instrum.*, **24**, 702–4 (*Aug.*, 1953).

To measure pH of brain and other tissues *in situ*, a micro glass electrode in capillary form was devised. The technique of fabrication and characteristics are described. Performance in the brain of the cat is briefly discussed. A.

MEDICAL SCIENCE . HUMAN PHYSIOLOGY 61

612.014.481 : 551.5

'Weather perception'—a solar effect. *See Abstr.* 8809

612.014.481.1

8824. A new technique for the study of the effects of X-radiation on mammalian skin maintained at different temperatures during exposure. J. P. O'BRIEN, J. A. BELLI, D. E. WOOD AND J. W. SAUNDERS, JR. *Science*, **118**, 135–6 (*July* 31, 1953).

Two parallel A.P. skin-deep incisions are made in

the back of an anaesthetised rat. The skin flap between the incisions is separated from muscles, and a small hollow lead chamber, which can be heated or cooled by water circulation, is introduced beneath it. The chamber is elevated so that its lower surface does not contact the underlying tissues. Heating and irradiation can thus be confined to a small area of skin only, without affecting the general metabolic level. Diagrams are given: experimental results are to be published elsewhere. D. V. MABBS

612.843.621

8825. Studies in physiological optics. VI. N. GÜNTHER. *Optik*, **10**, *No.* 5, 241–2 (1953) *In German.*

For Pt V, see Abstr. 6340 (1953). A distinction is made between geometrical and physiological magnification in terms of the object distance, the perspective distance and the distance of perception. It is deduced that, whereas the binocular magnification is 1, monocular magnification is 0·95. R. A. WEALE

612.843.621

8826. Studies in physiological optics. VII. N. GÜNTHER. *Optik*, **10**, *No.* 5, 243–4 (1953) *In German.*

The eye is considered as a simple microscope and the magnification is derived by means of equations previously obtained [Abstr. 1305 (1953)]. R. A. WEALE

612.843.

8827. Studies in physiological optics. VIII. GÜNTHER. *Optik*, **10**, *No.* 6, 303 (1953) *In Germa*

The physiological concepts developed in this se of papers are applied to the construction of mic scopes. It is shown that the inclination of the tu in a binocular instrument leads to a reduction of physiological magnification. R. A. WE

612.843.

8828. Studies in physiological optics. IX. GÜNTHER. *Optik*, **10**, *No.* 6, 304 (1953) *In Germa*

Whereas a telescope producing geometric minifi tion reduces the image also "physiologically," enlarging geometrically has no marked "phys logical" effect. R. A. WE

614.

8829. Further investigations of the protection eff of sodium thioglycolate against radiation inju K. ERDMANN AND I. MEYER. *Naturwissenschaf* **40**, *No.* 12, 347 (1953) *In German.*

An extension of work on muscle eggs irradia with u.v. [Abstr. 6347 (1953)] to a suspension epithelial cells of Axolotl exposed to the same ra tion. The nucleus becomes lighter on exposure sodium thioglycolate in $\frac{1}{4}$ molar concentration shown to protect against this while cystein ascorbic acid have no such action. F. T. FAR

TECHNICAL MATERIALS 66/67

666 : 539.172.4

Ceramic materials for reactors. *See Abstr.* 8693

666 : 539.213

Thermodynamic and kinetic properties of glasses. *See Abstr.* 8710

669 : 539.172.4

Zirconium. A structural material for nuclear reactors. *See Abstr.* 8694

PHOTOGRAPHY 77

771.37 : 539.27

8830. Exposure meter for the electron microscope. Application to choice of developer. G. CHAUME, J. GUILLAUME AND A. MATHIEU-SICAUD. *Bull. Soc. Franç. Minéral. Crist.*, **76**, 193–204 (*April–June*, 1953) *In French.*

The electron beam current density near the screen in an electron microscope is measured using a Faraday cage (1·5 cm dia.) in conjunction with a d.c. amplifier; the cage is swung out of position prior to taking an exposure. The paper describes in some detail the results of a series of measurements to determine the "γ" of two samples of photographic plates at a fixed current density for each plate, and subsequent use of various developers under carefully regulated conditions. The value of γ varies from 1 to 7, and dens time plots as well as a table of development conditi are shown; a calibration, for the two samples plates, of exposure time v. current density for a c stant maximum density (arbitrary) = 1·45 has been obtained. The need for a careful choice photographic emulsion, exposure time and devel ment process is stressed, such choice depending on contrast of details in a particular electron ima Development procedures for a number of example different kinds of subject are recommended.

A.E.I. RESEARCH LABORAT

778.34 : 535.

Photometric measurements of the ionization of tra in photographic plates. *See Abstr.* 8304